AD-A116 946 OFFICE OF NAVAL RESEARCH LONDON (ENGLAND) F/G 5/2
EUROPEAN SCIENTIFIC NOTES, VOLUME 36, NUMBER 5,(U)
MAY 82 D R BARR, N A BOND, D J PETERS
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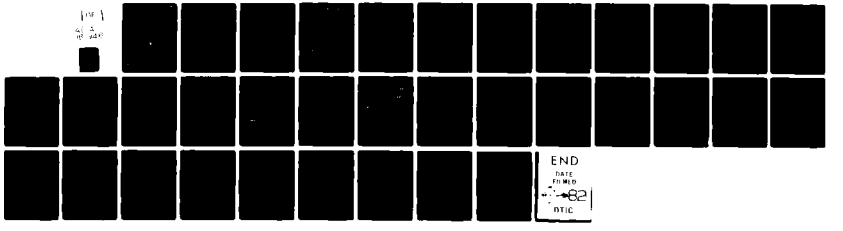

OFFICE OF NAVAL RESEARCH
LONDON

EUROPEAN SCIENTIFIC NOTES

ESN 36-5

31 MAY 1982

Distributed by the
Office of Naval Research Branch Office,
London

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SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 36-5	2. GOVT ACCESSION NO. AD-A116 946	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* EUROPEAN SCIENTIFIC NOTES		5. TYPE OF REPORT & PERIOD COVERED Monthly May
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR*(s)*		8. CONTRACT OR GRANT NUMBER*(s)*
9. PERFORMING ORGANIZATION NAME AND ADDRESS US Office of Naval Research Branch Office London Box 39 FPO NY 09510		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS		12. REPORT DATE 31 May 1982
		13. NUMBER OF PAGES 29
14. MONITORING AGENCY NAME & ADDRESS*(if different from Controlling Office)*		15. SECURITY CLASS. *(of this report)* UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

APPROVED FOR PUBLIC RELEASE: DISTRIBUTION UNLIMITED

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

This is a monthly publication presenting brief articles concerning recent developments in European Scientific Research. It is hoped that these articles (which do not constitute part of the Scientific Literature) may prove of value to American scientists by calling attention to current developments and to institutions and individuals engaged in these scientific efforts.

The articles are written primarily by members of the staff of ONRL and occasionally articles are prepared by, or in cooperation with members of the

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Aerospace Research and Development and the United States Army Research and Standardization Group. Articles are also contributed by visiting Stateside scientists.

EUROPEAN SCIENTIFIC NOTES
OFFICE OF NAVAL RESEARCH
LONDON

edited by Donald R. Barr, Nicholas A. Bond, Jr., and Don J. Peters

31 May 1982 Volume 36, No. 5

BEHAVIORAL SCIENCES

DECISION ANALYSIS IN THE INSURANCE INDUSTRY

At first thought, the insurance business would seem to be a good place for the decision analyst to operate. There must be, one imagines, gigantic data banks available, and the material in them could be converted into accurate probabilities of certain critical events (deaths, injuries, damage claims, and so forth). And since insurance companies deal in money, there would be monetarily-equivalent payoff values for many of the branches and twigs in a decision tree. For any given decision problem, then, one would need only to set up and fold back the tree, and the rank ordering of the alternatives would emerge. All very neat. Furthermore, one would think, insurance underwriters and executives would be good clients, as they would necessarily be trained in probability theory and familiar with such concepts as utility and expectation.

None of the above expectations holds true. At least they didn't for Prof. Lawrence Phillips at the Decision Analysis Unit, Brunel University, UK. During his several years of contact with the insurance industry he found that most of the underwriters he encountered were not statistically trained, that their daily activities were not concerned with explicit probabilities, and that they had only rudimentary notions of risk and expectation. How, then, could they write policies that could be sold and that would yield their companies a satisfactory profit? A general answer, which often came from the executives themselves, was that one gathers information, evaluates it, and comes to some decision; but such an answer is rather unsatisfactory. When Phillips started out as a consultant to the industry, one of his goals was to further the application of quantitative decision analysis; his successes and failures in that endeavor are generally instructive for analysts who try to introduce new technologies into a real-world arena where large amounts of money and highly significant issues are at stake.

Phillips quickly found that, like many other executives, insurance underwriters often could not fully explicate their judgmental processes to an outside person. When they were pressed, a few heuristics might emerge: an executive might say, "Well, if you don't know much about a given accident risk insurance, write it for a while on a rather small sample of customers who have been either very good or very bad risks before, and see how it stands up." Such rough rules are often plausible and useful. But heuristics may not remain valid (if they ever were valid) from one domain to another, or from one decade to another. Factors such as new laws, accounting and government agency practices, and court awards can introduce uncertainties. Many large companies actually have reported underwriting losses over recent years; in some cases, only their investment income has saved them from bankruptcy.

After suitable preliminaries, one company elected to introduce decision analysis via a five-stage process:

(1) Commitment at executive level to systematize decision making.

(2) "Dialogue period" between decision analyst and company people to understand better each other's language.

(3) Preparation of a tailored seminar to demonstrate how decision analysis might work in the industry.

(4) Pretesting and administration of seminar to underwriting managers.

(5) Report-back by seminar participants regarding their use of the seminar models and methods.

During their careers, many analysts have presented short courses in decision theory; in fact, one leading figure was heard to remark that, if suddenly awakened in the middle of the night and led to a blackboard, he might start drawing the tree for Raiffa's famous oil-wildcatter problem. For the insurance executives, Phillips was careful not to rely on the general appeal of the decision model; in fact, he first had two underwriters attend decision courses at Brunel and then try to use the material in real insurance problems; this allowed the development of special case studies that were almost guaranteed to be interesting to insurance people. The case studies were then examined intensively in the seminar as it was presented to some 20 executives.

The seminar was regarded positively by those who attended it, probably because the case studies were so obviously relevant, because the two insurance people who worked up the case material were included as part of the instructor staff, and because the administration was done by the insurance company and not by a consulting company or university. When each attendee filled out a questionnaire a few months later regarding the utilization of material that was encountered in the seminar, nearly all thought that decision analysis was useful. The most relevant part of the material had to do with probability definition and estimation; practically nobody actually drew a decision tree or went through the business of folding back a tree to discover the optimal decision to take. This operational result is both positive and negative: via a carefully constructed short course, you can introduce precise concepts, but

these ideas cannot really be expected to be grasped or utilized immediately.

After the seminar period, the analyst was engaged by the company to visit various company locations and, when feasible, to attempt relatively brief decision analyses of active problems at the site. As part of his toolbag, the analyst carried with him a portable computer and software program that could assist in the construction and analysis of moderately sized decision trees. An editing mode permitted revision of the tree structure and of the probabilities and utilities, and of course there was a hard-copy output of expectations for each decision-making option.

The availability of the analyst and his portable software package led to the development of several small models in the insurance company. These often took only a couple of hours to produce and to run; although such time restrictions meant that rigorous scaling of values could not be done, it often happened that certain options could be eliminated and that the whole business of structuring the problem could be improved. One interesting example had to do with the evaluation of alternative insurance packages for a client. Several major objectives were listed and weighted from the standpoints of both the insurer and the client; while this exercise was not the most complex application of multiattribute utility theory ever reported, the explicit weighting process gave a useful delineation of the problem and made it easier for the company to negotiate with the client.

As noted above, despite the fact that they are in a statistical business, underwriters often have little knowledge of statistics. In response to several problems he encountered in predicting "burning cost" (expected value of next year's claim), Phillips provided a linear prediction procedure in his software kit. This procedure was put into an easy-to-follow, 10-step sequence, so that a nonexpert user could insert previous data, and the program would produce cost predictions. (This particular program was set up so that any one of three predictive submodels could be employed—another recognition of the fact that the user should feel that he was influencing the analysis and was not just applying some canned but unknowable mystery to the problem.)

The lessons from this particular industrial involvement may be quite far reaching. Among the most important is the "how to get in" history. The way to get in, after obtaining the initial high-level commitment, is to have problem materials that are industry relevant and industry immediate; textbook problems, whatever their appeal to the specialist, are not enough. After you get in, then what? Judging from the Phillips account, a good thing to remember is to start small and to accept scaled-down benefits from the analysis; then, even if an optimal policy cannot be calculated, a decision-maker may see that the strict "comparison" requirement of setting up the problem has improved his grasp on reality.

If a technologist has a few explicit models that can be easily conveyed and quickly perceived as useful, the models can contribute to the overall acceptance of the concept. The burning cost prediction scheme that Phillips used might seem simple to statisticians, but its accessibility and flexibility must have had a strong appeal to the industry clients.

Military decision-analysts and systems people might ponder some differences between this rather low-and-slow experience of a British academic in the insurance industry and the way that military decision-aiding projects go forward. For their military proposals, manufacturers often suggest gigantic configurations of computers, displays, and communication devices. Many years and many dollars may be expended before the big system reaches the trial stage, and when it does, it is often disappointing. Would the big-military-systems history have been any more positive if this same kind of modest but solid introduction of decision-theory ideas had been done first?

Nicholas A. Bond, Jr.

ONR London

DIPLOMATIC SHUTTLE STRESS

During the April 1982 negotiations over the Falkland Islands, US Secretary of State Alexander Haig made several trips between Washington, DC, Buenos Aires, and London. The length of the flights and the strenuous schedule upon arrival caused much discussion regarding the impact upon all the principals involved, and particularly the effects upon Secretary Haig, who was 57 years old and had undergone coronary artery surgery 2 years earlier. Officially, Haig felt fine, and he even played tennis in between his April crunch of meetings, but all the activity must have exacted high metabolic and hormonal costs from him.

By coincidence, the effects of the Buenos Aires-London run on airlines personnel and passengers were studied a few years ago by a team of English and Argentine investigators headed by Malcolm Carruthers of St. Mary's Hospital, London (now at Maudsley Hospital, London). The Argentina-London run is over 7,000 miles long; it goes a quarter of the way around the world in terms of latitude and one-sixth of the way around in longitude. For his observations, Carruthers chose the month of January, the time of year when Britain experiences its coldest weather while Argentina is in the hottest part of summer. Fasting venous blood samples were taken at 24-hour intervals, starting a short time before the flight left Buenos Aires; urine samples were collected every 4 to 6 hours. EEG (Kaiser) and EKG (V_6 position) recordings were made on each of

the three pilots during the flight. Most measurements were continued for 2 days after the flight was completed, so the whole project embraced 4 days, with takeoff from Buenos Aires at 1700 hours on day one.

Blood cholesterol and fatty-acid levels were stable over the 4 days, while triglyceride and glucose levels rose during the flight and returned to preflight figures on the day after the flight. Plasma cortisol was lower on the third and fourth days.

Aircrew urine adrenalin was normal during the flight but became very much higher by the fourth day; noradrenaline was higher for all samples taken except for the second day. This agreed with an earlier study, which found postflight adrenaline and noradrenaline levels rising to 260% and 159% of control levels. Heart rates rose during all the landings and takeoffs as expected, reaching about 125 per minute on the Argentine and Brazilian takeoffs; these peaks were lowered somewhat, to the 110 range, for the later takeoffs and landings in Madrid, Paris, and London. Figure 1 shows measurements taken over the 4 days against a quotidian background of control measurements in a ground-based sample of age-matched people.

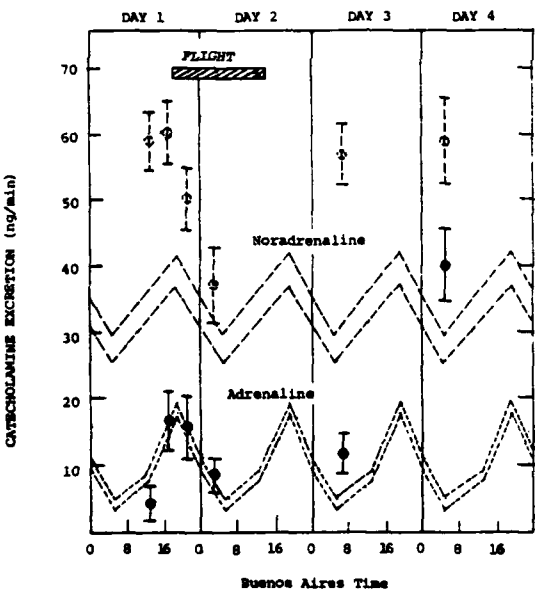

Fig. 1 Noradrenaline ○ and adrenaline ● excretion in fifteen subjects (mean ± S.D.)

Although EEG data for the pilots were probably not very reliable because of the cockpit recording situation, there were some disquieting indications. Two pilots showed "microsleep" EEG patterns, with spindles and waves in the 12 to 14 Hz region and mass synchronization. It might not be an exaggeration to say that these men were asleep with their eyes open. The two flight engineers showed very-low-frequency EEG rhythms, which are typical of drowsiness. Most of the data obtained from the aircrew and passengers are consistent with the idea of persistent stress effects following long flights; although this particular study did not experiment with the latitude variables, there is certainly the suggestion that rapid latitudinal changes may heighten the stresses that would be caused by any long flight.

Carruthers did not give psychological tests to his subjects before and after the flight, but other work has found that the decrements in aircrew scores from flights are often surprisingly small. To a large extent, this may be because aircrew members are nearly always young, very healthy, and used to being tested, and because they can readily mobilize their resources, at least for short periods.

Inasmuch as unremitting stress cannot fail to have negative effects on the middle-aged people who do the "shuttle diplomacy," it is worth asking why that negotiating technique is so popular these days. The memoirs of diplomats often say that an exhausting, high-tension shuttle can have energizing effects on all the participants involved; the nontraveling diplomats also seem to feel the pressure for something to report and may therefore be inclined to concede a little more to the shuttle person. The international publicity and suspense also can be seen as constructive in at least some circumstances.

It is regrettable that knowledge in this domain is so imprecise that psychologists cannot offer much help in deciding where the tradeoffs lie between the positive effects of energizing and the negative emotional and intellectual effects of an arduous shuttle episode. What is certain, however, is that the cumulative negative effects are bound to be greater in the older people who perform diplomatic shuttles than those observed in younger aircrew samples. This means that various possibilities for protecting the shuttle person might be explored. Carruthers proposed that, when a key person does a continuous shuttle activity, the persons meeting him, say in Buenos Aires, should be required to meet his natural hourly working and eating schedule. Such an arrangement might favor the shuttle traveler slightly at the expense of his hosts, who could be meeting in the middle of the night and therefore upsetting their own bodily rhythms. But even given such an arrangement, as Carruthers' work showed, the flight itself will inevitably exact its penalties from the traveler.

It might well be worth proposing, as standard diplomatic practice when international crises erupt, that adequate time be allowed for shuttle diplomats to recover their normal bodily rythms. Such practice could be considered as one of the indispensable requirements for productive negotiation. It would also provide a

diplomatically desirable cooling-off period for all concerned.

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ONR London

COMPUTER SCIENCES

CLOSELY COUPLED COMPUTER SYSTEMS

When examining multiple computer systems, it is frequently helpful to classify the system organization according to the degree of coupling between the individual computers within the particular system. Closely coupled systems are those in which each computer has a memory capability dedicated to its own private use, and in which, often but not always, there is a supplemental memory resource available to be shared by all the computers in the system. The real distinction between close and loose coupling in multiple computer systems is that in closely coupled systems, individual tasks are broken into parts that are assigned to various computers so that the computers can be thought of as sharing in the execution of the talk, while in loosely coupled systems each computer usually does an entire task, and only the results are exchanged between computers.

When we think about solving a problem, most of us are used to thinking sequentially. In working with closely coupled computer systems, we must revise our habits and organize the solution to fit efficiently into a parallel pattern. The decomposition of sequential algorithms into a group of algorithms suitable for concurrent processing seems conceptually straightforward, but it is not easy. There are many classes of problems, however, in which even strenuous efforts would be worthwhile, because to date we have been unable to find algorithms or computers powerful enough to provide sequential solutions within a reasonable time. Digital signal processing, speech analysis and synthesis, and target identification are among the subjects that could benefit from efforts which are now being made to master closely coupled systems.

At the Loughborough University of Technology (LUT), UK, Prof. David J. Evans heads the Department of Computer Studies, and he and his associates have established one of the key centers in the UK for the study of closely coupled computer systems. (The details of LUT research in this area are described in the following article of this ESN issue.) To satisfy the need for a powerful research test bed, Evans has built a closely coupled multiple computer system called NEPTUNE.

NEPTUNE is a parallel processing system consisting of four Texas Instruments 990/110 minicomputer processors connected to one another through a system of five buses. There are four local buses, each of which links one processor to 96 kilobytes of random access memory. A fifth common bus is connected to the four local buses through appropriate coupling and isolation circuitry. The common bus provides access to a shared disc file with a capacity of 50 megabytes and a shared random access memory of 64 kilobytes. Each computer thus has a combined memory capacity of 160 kilobytes. The shared memory is controlled by one processor that alone is able to allocate blocks within the memory. As the entire memory can be accessed by all processors, a small area of the memory, dedicated to interprocessor communications, contains information used by all as to the location of any shared memory allocations.

The hardware architecture of NEPTUNE is straightforward, and it is probably evident that the biggest challenge associated with NEPTUNE relates to the decomposition of any algorithm to be used on the system. Such decomposition must produce a set of parallel programs that will exercise all four processors efficiently and will not require excessive overhead time to be spent on synchronization or information exchange. Each individual parallel program is divided into two parts, one of which contains the program code to be run and local variables, while the other contains shared variables. Some applications have already been run on NEPTUNE and take about 28% of the time which would have been required to perform the same processing on a single sequential computer; at these efficiencies, an overhead of 10% is quite acceptable.

The above results were presented at a demonstration of NEPTUNE that opened a workshop on closely coupled systems chaired by Evans and held at Loughborough on 6 and 7 April 1982. Between 30 and 40 specialists in closely coupled computer systems were in attendance, many of whom were the junior lecturers and research fellows specializing in this field at a handful of British universities (LUT, Univ. of Sussex, Univ. of Manchester, Univ. of East Anglia at Norwich, Hatfield Polytechnic, and Polytechnic of Central London). Jointly sponsored by LUT and the UK Science and Engineering Research Council (SERC), the workshop addressed a number of themes of strong current interest: requirements for parallel languages, program decomposition for closely coupled systems, and fault detection and recovery in closely coupled systems.

In the first technical session after the NEPTUNE demonstration, Dr. G. Shoza (Univ. of Sussex, Brighton, UK) discussed concurrency requirements and their implementation in a multiprocessor environment. Actually, the paper presented the results of a study of the Ada Intertask Communications Primitives and their implementation on a multiprocessor computer system. To accommodate concurrency in closely coupled systems, a programming language should have good facilities for communication and synchronization between parallel paths; also required are well-structured compile-time checks to assure correctness.

Languages such as Concurrent PASCAL, PASCAL PLUS, and MODULA use monitor concepts that combine high- and low-level constructs, thus limiting the architectural freedom of application of these languages. It was hoped that Ada would be somewhat freer of such limitations and would also be responsive to further requirements imposed by concurrency: information transfer, identification of communicating tasks and partners, a degree of nondeterminism, and provisions for absorbing failure or delay in parts of the system.

Since no complete Ada complex was available, Shoza implemented Ada tasking features to supplement a PASCAL compiler and then studied the performance capability of the resulting combination. He concluded that Ada was disappointing in terms of its suitability for use in closely coupled systems and that it was limited in many applications by the absence of a broadcast facility. He also found that, though Ada was easy to use in conjunction with shared memory multiprocessor systems, its advantages disappeared when one attempted to use Ada in systems without shared memory. Finally, he found that in many applications likely to be found for closely coupled systems, Ada overhead requirements for input-output interrupts due to entry calls were likely to be unacceptably high.

In the same session, Dr. Javed Shanechi of LUT delivered a paper on methods for matching algorithms to computer system architecture. The authors were interested in comparing several different approaches to parallelism as alternatives to the hitherto conventional sequential solutions for locating the eigenvalues of real symmetric tridiagonal matrices. This writer assumes the importance of such problems, but will hereafter report only on the aspects of the activity of interest to computer specialists.

In the Distributed Array Processor (DAP) manufactured by International Computers Ltd. (ICL), a single control processor operates in connection with 4,096 one-bit slave processors, all of which can execute the same instruction at any given time but on different data. For each instruction, any specified combination of slaves can be deactivated. The control processor can broadcast the same data to all slaves or, alternatively, each slave can move its data to an adjacent slave. Performance depends on the length of the data, with addition time increasing as a linear function of word length and multiplication time increasing as the square of word length.

On the Cray-1S vector processor, computing power is achieved by pipelining or causing successive steps to start without waiting for all preceding steps to finish, but both techniques (array and vector processing) suffer in such cases because of the great need for synchronization. To put it another way, algorithms calling for a high degree of synchronization work better.

On an asynchronous system like NEPTUNE, the algorithms must be quite different. Shanechi did not offer any clues to help select one of the three types of parallel systems by comparing them with one another, but rather compared each of the parallel techniques to a sequential solution on the related single computer. Thus, for a solution involving 4,096 eigenvalues, the DAP ran more than 50 times faster than a conventional ICL 2980 computer (the DAP host). And the Cray-1S sequential solution took seven times as long as the Cray pipelined solution. The NEPTUNE provided a speedup factor of 3.7 compared to what would have been achieved by solving the problem on a single computer.

Dr. L. Dixon (Hatfield Polytechnic, UK) discussed the role of parallelism in optimization and presented preliminary results of work done on NEPTUNE and the DAP in areas where good sequential algorithms exist. Parallel systems seemed appropriate if the sequential solution took too long or if the size of the problem was too big to attack sequentially. At least four types of optimization problems were named as being amenable to parallel solution:

(1) Small-dimensional problems in which the time required for optimization is much less than total time.

(2) Small-dimensional problems in which the time required for optimization is approximately as great as the total time available.

(3) On-line problems in which the time available for optimization is very small.

(4) Multiple small problems, each requiring optimization.

Dixon showed preliminary results for some of the cases, and his findings seemed to indicate that, if a two-step refinement were used, enormous improvement over sequential solutions could be achieved. In the first step, he developed a straightforward parallel solution and ran it. The second step was a rerun, made after the major time-consuming components of the first parallel solution had been identified and improved. He indicated that even when the original sequential solution had been well optimized, a reimplementation on n-parallel paths could produce much more than n times improvement.

Jane W. Hughes (Univ. of Manchester Inst. of Science and Technology, UK) discussed the development of a parallel programming language, Distributed Translation Language (DTL). This effort was motivated more by the desire to respond to programmers' needs than to comply with parallel hardware structures.

She started by tracing the history of the effort from 1970, when Wirth and Djkstra implemented stepwise refinement in the strongly hierarchical PASCAL. By 1976, Parnas and Liskov had implemented concepts of data obstruction encapsulation in CLU, a language in which the hierarchical structure was suitable for good control of sequential solutions. By 1978, the ideas of "Process Abstraction" had been advanced by Hoare and Jackson; that approach used concurrency, which is not hierarchically structured as a design tool. DTL, then, is designed to add the benefits of hierarchical structure to design of a parallel system and has been constructed to allow the specification of hierarchical structures of networks of concurrent processes, structures of structured translations, and communications on fully synchronized data streams. DTL is adaptable to various hardware architectures, both closely coupled and loosely coupled.

Dr. M. Woodward spoke on reliability in NEPTUNE. He described techniques for identifying failures in the system and for restoring the system to proper operation in a new configuration that bypasses the failed element, through the use of an abstract resource ring (ARR). The ring is a master scheme for system resource control in which notional ownership of resources passes around a ring from the current user of the resource to the next one requiring it. There will be one ARR for each resource in the system. The scheme has not been implemented yet but deserves evaluation.

Dr. David A. Duce (Rutherford Laboratory, Oxfordshire, UK) is the academic coordinator for the British National Science and Engineering Research Council (SERC). He pointed out that SERC now also has an industrial coordinator available to attempt to find ways of exploiting the undeniably impressive academic achievements of SERC's Distributed Computing Systems Programs (ESN 35-8:298 [1981]). The SERC program remains a national and world asset and it might be noted that two important investigators in the program (D. Aspinall at the Univ. of Manchester, and Y. Paker at Polytechnic of Central London) are also doing work under grants from the European Research Office of the US Army Research, Development and Standardization Group, UK.

Y.S. Wu (US Office of Naval Research, London) observed that the greatest chance for exploitation of this class of parallel computing technology lies in the digital signal processing field. Unfortunately, the two fields represent different disciplines and the two communities seldom communicate with one another. On this occasion, at least, Wu was able to make one community aware of the other.

An overall assessment of the meeting leads to one conclusion about the subject matter, and also to one about the British and European methods of holding meetings. In distributed computer systems, it is clear from this workshop that progress in Britain is respectable and characterized by restraint, intense professional discipline, and modest quantities of resources applied. Emphasis is heaviest on the deliberate preliminary stages of performance analysis and evaluation of alternative architectures rather than on the early commitment to the construction of potentially interesting test beds.

Workshops like the one discussed here are by invitation only; they are not intended to offer outsiders an opportunity to observe the work before it has reached the state of completeness at which it is published in internationally read journals generally available to US scientists. Rather, they are intended to permit two-way, or n-way exchanges of ideas among the small group of dedicated professionals at the center of any technical community. In this way they tend to be quite different from similar meetings in the US, which, intentionally or not, most often become forums for the dessemination of information to the community at large. The workshop on closely coupled systems represented a valuable glimpse of the exchange process working very effectively.

G. M. Sokol

US Army European Research,
Development and Standardization
Group, UK

RESEARCH ON PARALLELISM AT LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY (UK)

Performance Analysis

Among the research projects in the Department of Computer Studies at the Loughborough University of Technology (LUT), Loughborough, UK, there is a particular emphasis on performance analysis of parallel algorithms and parallel computers. Performance analysis can determine computer throughput and possible bottlenecks within a particular computer system for various types of processing loads. Parallelism can be introduced into a processing algorithm in several ways and the resulting programs will make different demands for parallel resources. Parallel programs always require more than one processor, communication of shared data, and synchronization of parallel processes among processors. Several demands may compete for a shared resource. This may create a performance limit on the resource and increase the processing overhead associated with the arbitration of the demands and the queuing (or waiting) of requests.

The pattern of demand for each resource varies from program to program with respect to different parallel architectures. The performance measure for parallel computing can be defined in at least two ways: as the ratio of speed of a program on n processors to that on a unit processor, or as a percentage of potential output of n independent processors. The

LUT approach to the problem is to develop a quantitative view of the demands for all shared resources made by algorithms to a parallel system. Such an analysis concentrates on the inherent limitations on the performance due to competition for a system comprising n processors that are operating asynchronously to complete a common task. The constraint that all the processors are working on a common task requires sharing of information, and the shared information needs to be changed dynamically during processing. Conceptually, each processor must access a shared data base, process the results, and store them. A system with n identical processors can perform the task n times as fast as a uni-processor only if the overhead access to the shared data base and the capacity to store the processed results are exactly the same as for a uniprocessor. Such operation is impractical, because the task must be subdivided into n or more separate subtasks either before the processing starts or during processing. If n subtasks are not available at any time, all processors cannot be busy at the same time, so some must be idle. If one subtask generates results that are required as input to another subtask, at some point the latter subtask will be unable to proceed until the former subtask has been completed. This implies a need for the overhead of sequencing subtasks properly. If the number of processors that can access the data base simultaneously is less than n, there will be an overhead associated with checking to insure that the number of simultaneous accesses is not exceeded. Time also will be wasted if processors have to wait to gain access.

For the above reasons, LUT identified two distinct classes of overhead. The first kind of overhead is due to the design of software and hardware and encompasses such matters as subdivision of the task, allocation of the tasks to processors, checking by hardware and software for contention on accesses to the database, and checking for correct sequencing. These are all static once the number of processors, the methods of communication, synchronization and task allocation, and the algorithm to be processed are decided, because the number of subtasks, the number of synchronizations, and the number of accesses are all properties of the algorithm itself. A second class of factors includes those due to the interference between two or more subtasks that are running on different processors and that cause one or more of the processors to wait. This dynamic cost depends both on the algorithm and on the detailed timing considerations, which may vary even if the same task is executed on the same hardware on consecutive occasions.

LUT formulated the performance time of a multiprocessor either as a speedup factor S or in terms of the time not used productively, W, where

$$S = \frac{T(1)}{T(p)} = \frac{\text{time taken on a single processor}}{\text{time taken on a p processor sys.}}$$

or

$$W = p*T(p) - T(1) = \text{the sum of times taken by the p processors to complete their subtasks less the time taken on a uniprocessor.}$$

The time wasted must be equal to the sum of the static and dynamic overheads. If algorithm design time is ignored this would be

$$W = tA + \sum_j q_j B_j \sum_k r_k C_k + \sum_{i=1}^{p} (W_i + \sum_j X_{ij})$$

where t is the number of subtasks

- A is the creation and allocation overhead for a task
- B_j is the overhead associated with an access to the jth type of resource and q_j is the number of accesses to this resource
- C_k is the overhead associated with the kth synchronization method and r_k is the number of such synchronizations
- W_i is the time the ith processor is idle waiting for subtasks to be allocated
- X_{ij} is the time the ith processor waits for access to the jth resource.

The first three terms give the static overhead; the rest is the dynamic overhead. The S and W measures are related such that

$$T(p) \geq \frac{T(1) + W}{p}$$

and

$$S \leq \frac{pT(i)}{T(i)+W}$$

The maximum possible speedup factor of a given algorithm is realized when the dynamic overhead is zero. As noted above such a situation is virtually impossible.

A communication-based system that consists of processors interconnected by a network differs greatly from the closely coupled system discussed above. For this kind of system, the static overhead includes: (1) the time required to establish local copies of required parts of the data bases in each processor, (2) the time required for sending messages among processors, and (3) the time required for

updating the local data bases to incorporate the messages. Under these circumstances, the dynamic overhead involves only the shared resource, the network communication system.

The Parallel Processor Testbed

The parallel processor testbed at LUT is called the NEPTUNE system. It is based on 4 Texas Instrument (TI) 990/10 minicomputers. The configuration is shown in Figure 1. The system is connected by 5 buses (TILINES). Four TILINES are local buses for 4 processors, each with access to 96 Kbytes of memory. Each of the TILINES is linked with the 5th shared bus via a standard TILINE coupler to add 64 additional Kbytes of memory and 50 Mbytes of disc storage. Each processor has access to 160 Kbytes of memory.

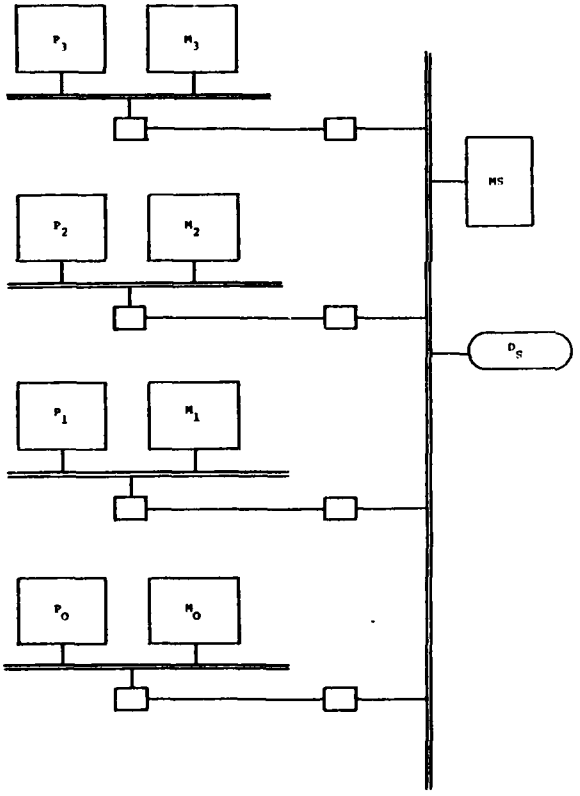

Fig. 1

Under the control of the manufacturers' standard multitasking operating system (DX 10), programs are allowed to exist in three segments and tasks are set up to share data and program in one processor. A parallel program designed to be run on the system consists of two parts: (1) program code and local data, and (2) shared variables. LUT modifies the software to allow the commands used to generate the parallel programs and thus ensure that two parts of the program can reside in different segments. Parallel programs are initiated from one processor, which loads the shared segment into the shared memory and then flags the cooperating processor with the starting address of the private segment. Requests for mutual exclusion and for the generation and termination of parallel paths are handled by calls from the user program to specified control routines linked with the user program as part of the parallel program module. The LUT developed software allows a user to specify the start and end of parallel processes and the critical sections of codes involved.

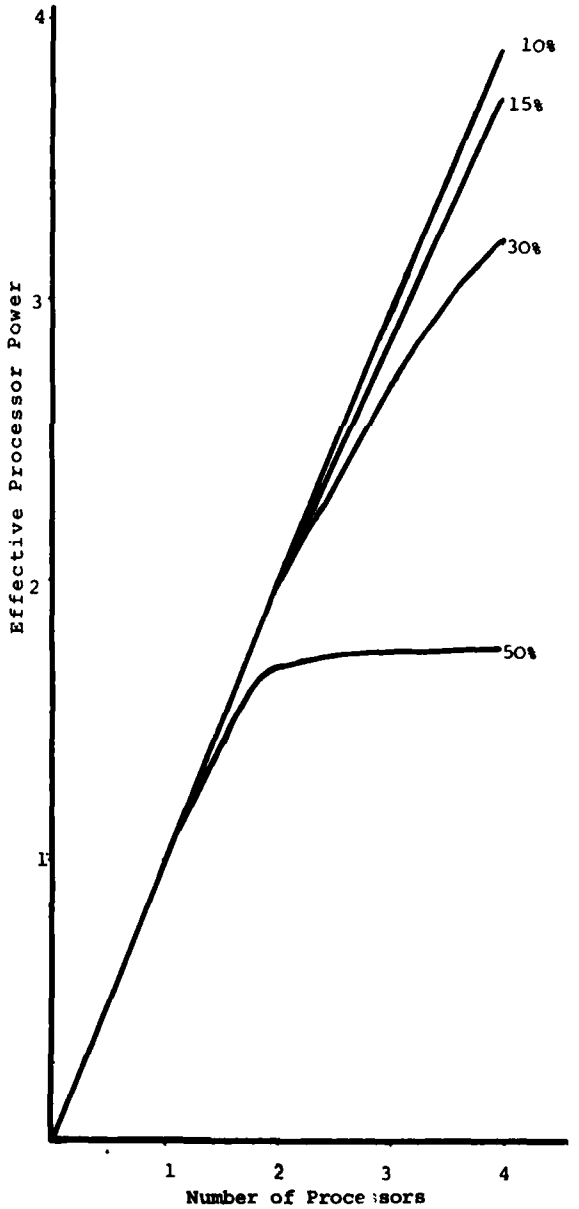

Fig. 2

Parallel processes are generated and allocated to processors dynamically; the scheduling is achieved by means of a shared list of processes protected by mutual exclusion. The dynamic loss of performance arising from "contention" is measured by software. Several test programs were designed to measure the losses from multiple requests to a block of shared memory. The programs generated rates of accesses to the memory not normally achievable from user programs. Some results are summarized in Figure 2 on the preceding page. The curves represent programs that would use 50%, 30%, 15%, and 10% of the shared memory cycles if the program were run on only one processor. In the 50% case with 4 processors, one processor suffered starvation and crashed. Contention losses due to mutual exclusion applied to data structures are shown in Figure 3.

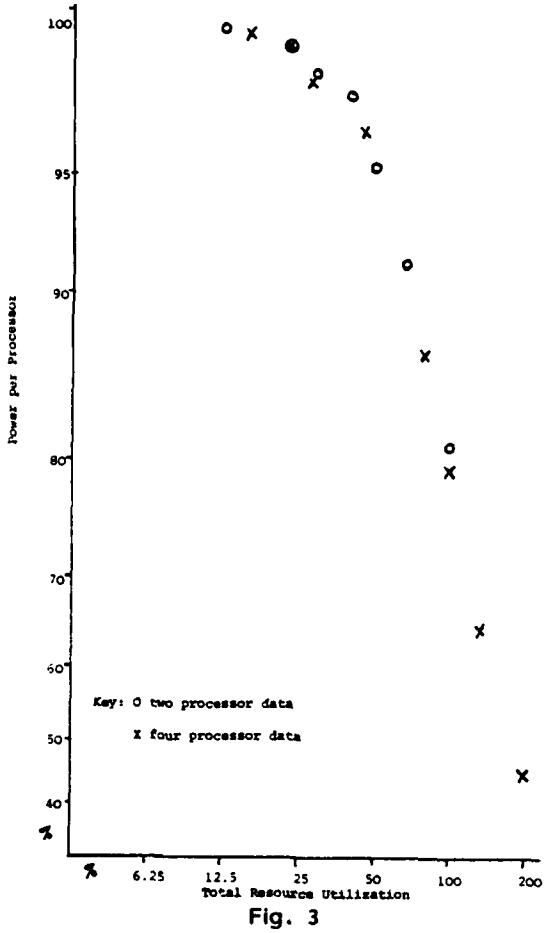

Fig. 3

LUT used a random number generator to have irregular access patterns in order to measure contention on shared data structures, along with some special programs to measure contention effects. The test programs generated a known mean rate of access to a data structure protected by mutual exclusion. The mean was calculated from the relative amounts of time spent updating the resource. The results, reflecting asynchronous contention for shared resources, are shown implicitly as related only to percentage utilization levels in Figure 2.

Summary

Performance analysis and testbed experiments enable LUT to quantify the closely coupled system behavior of parallel processing. In addition, comparative studies have been pursued in regard to execution of parallel algorithms on several different architectures, namely, Cray-1, Distributed Array Processor (DAP), and NEPTUNE. The algorithms are multisection method for eigenvalues, successive line overrelaxation, global optimization, and sort & merge. The Loughborough work is another good example of the UK approach of attacking the problem by analysis and conducting experiments on existing equipment, rather than by quickly committing R&D resources to possibly premature hardware construction.

Y.S. Wu

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ENGINEERING

THE SWISS FOUNDATION FOR RESEARCH IN MICROTECHNIQUES

Over the last decade or so, the Swiss watch industry has lost a significant part of its share of the world market to American, Japanese, and Hong Kong based companies. The industry, with the support of the Swiss federal and cantonal governments, is now mounting a long-range campaign to recover its position in the marketplace. A focus for the effort, as it relates to research and development, has been designated; it is the Fondation Suisse pour la Recherche en Microtechniques (FSRM). FSRM recently moved into a 5,000-m² facility in Neuchâtel, the traditional center of Switzerland's watchmaking industry, and it is setting up a teaching and research-and-development laboratory there. Plans call for a research-staff level of about 20, in the 1982-83 period, offering third-cycle (i.e., PhD level) courses and thesis support in the field of "microtechniques," a term that includes the design and application of microelectronic and small mechanical systems and devices and the measurement of micromechanical motion. FSRM has already begun to channel both governmental and industrial funds to the watch-related research activities at the two Swiss Federal Institutes of Technology (ETH-Z in Zürich and EPF-L in Lausanne), at several cantonal universities, and at several industrial laboratories

(e.g., the Centre Electronique Horloger [CEH] and the Laboratoire Suisse pour la Recherche en Horlogerie [LSRH]). As might be expected, the cantonal university that is most active in the program is the Université de Neuchâtel (UNe).

The research at UNe is concentrated in the Institut de Microtechnique (IMT), which, roughly speaking, is UNe's electrical engineering department. Three professors and about 30 graduate students make up the research staff of the institute. Prof. Fausto Pellandini, the head of IMT, described the organization's general research program and its relationship to FSRM. IMT is divided into two groups, one working in the area of electronic circuits and systems and the other specializing in optical measurements and applications. A third group, which will specialize in microtechniques and sensors (and, presumably, will have the closest relationship to FSRM), is to be established sometime in 1982, after the arrival of a new professor who will head the group. Until that time, the electronics group will provide the primary support to FSRM. Pellandini shares responsibility for leading the electronics group with Prof. Arvind Shah, while Prof. René Dändliker heads the applied-optics group. The institute is relatively young (it was formed in 1978) so it is not burdened with a classical electrical-engineering department's commitment to heavy electrical machinery. Its character is shaped by a relatively young staff, headed by the three professors, and by the physical environment, a converted watch factory whose unplanned obsolescence serves as a constant reminder of modern technology's challenge to Swiss industry. The latter factor is reflected in a tight-lipped attitude on the part of the staff in discussions related to research being done there that is supported by industry; this gives the visitor to IMT the impression that it is more like an industrial laboratory than an academic one.

Pellandini indicated that they had just completed the development of a speech-recognition system for use in simple control and measurement applications. The system is designed to operate with a single speaker, who trains it by providing 3 samples of each isolated word in a 20-to-40-word semantically structured vocabulary. It is designed to operate in a mild noise environment, providing a reaction time of about ½ s with an error rate of about 4%. He described its complexity as that which could be accommodated by one CMOS integrated-circuit chip. (But that chip has not been produced; the sponsor, which had not given permission to have its name released, had not yet decided whether it would develop the system for production.) On the basis of its experience in that developmental effort, IMT has been granted federal support to extend speech-signal-processing research. The effort will include single- and multiple-speaker speech and speaker recognition, and will envision applications in the telecommunications, microdevice-manufacturing, and security industries. Industrial support has also been granted by CEH for a speech-processing project. (This seemingly incongruous relationship—speech and timekeeping—points out a significant change in the thinking of the watch industry's planners: They want to develop a whole new array of devices that will be wrist-borne; if it will fit inside a watch case, it qualifies for consideration as a possible product.)

Medical electronic devices are also being developed by the electronics group. Two such devices were mentioned in that context: a sphygmomanometer-related signal processor and an ovulation detector. The sphygmomanometer problem is one in which the acoustic noise produced by blood flowing through the arteries (Korotokoff noise), which has its significant spectral components in the 20-to-100-Hz range, must be separated from the heartbeat pulse signal, which has its significant spectral components extending up to about 10 Hz. (Korotkoff-noise measurements are used to pinpoint the values of systolic and diastolic blood pressure as the external cuff pressure being applied to the artery is varied.) Pellandini believes that the very-low-frequency filtering requirement, coupled with the time-varying nature of the signal, precludes the use of switched-capacitor filters, so his group has developed an integrated "quasi-continuous" form of digital filter specifically designed for medical-electronic applications. The integrated circuit used in the sphygmomanometer also includes the capability to control the applied pressure, to detect the critical pressures, to measure the pulse rate, and to store the results for future comparisons.

The ovulation-detector project, which is just getting started, is supervised by Shah. Shah indicated that the classical body-temperature-measuring technique was recently tested by the United Nations' World Health Organization and found to be too unreliable. He hopes to receive support from Fonds National Suisse de la Recherche Scientifique, the Swiss counterpart of the US National Science Foundation, to study the problem, but at present, the researchers at IMT are still trying to define the physical measurement(s) that will provide a reliable indication of ovulation and will also be simple enough to be carried out by unsophisticated users (patients) with some sort of inexpensive device.

The group's dedication to miniaturization also extends to the design of sensors and the associated interfaces between the sensors and the data processor-controller. Pellandini described some miniature thermometers (quartz crystals cut so as to enhance their resonant-frequency sensitivity to temperature changes) and other piezoelectric transducers used to measure pressure, velocity, and displacement. Sensors for use in fluid-flow and chemical measurements (e.g., pH and ion concentration) were also being developed. The group is attempting to integrate the sensor an

associated preprocessor for the signal, and the system interface electronics on a single chip for as many cases as they can. The control and data-bus designs being considered are all based upon two-wire multiplexed systems, again for the purpose of making that part of the system as small as possible.

IMT's preoccupation with a micro world is sometimes relieved: Shah described one project that seemed gargantuan in the context of IMT, namely, the analysis and optimization of residential installations of solar-energy collectors. In particular, IMT will study hybrid systems, i.e., those that combine thermal collectors and photovoltaic converters. Shah takes issue with the conclusions recently published by a committee of the American Physical Society (APS), which had been studying the same problem. He commented that the APS study concluded that such systems would not be cost effective in the near future, but he feels that their cost projections were questionable and that the difference in space limitations (for larger systems) that exist in the European environment may also lead to a different set of conclusions and recommendations for future developments.

Before we left the subject of electronic devices and systems, Pellandini spoke again about the critical problem facing Neuchâtel's watch industry. IMT's research in support of timekeeping systems includes the development of microprocessor chips specifically designed for wristwatches and the design of software tools for use on those projects. The severe limitations on both size and power dissipation in watches (chip area $\leq$ 40 mm^2; power dissipation $\approx$ 2 to 3 μW) and the demand in the marketplace for a wide variety of time-related and other (e.g., game-oriented or biological-measurement) functions has led IMT to consider a variety of specialized architectures for such uses. In particular, the researchers evaluated the trade-off relationship between chip area and power consumption for a variety of levels of complexity of the instrument by comparing different algorithms for enlarging the time data, different instruction sets, memory-address methods, interrupt systems (for changing modes), and parallel-versus-sequential processing approaches. The work is continuing at IMT under FSRM sponsorship, in cooperation with Centre Electronique Horloger (CEH), EPFL, and Asulab SA, a watch manufacturer located in Neuchâtel. A report on the work was presented at the EUROMICRO Conference in Paris in September 1981; it concluded with the recommendation that a parallel-processing architecture be employed in order to constrain the power consumption. While the report did not deal explicitly with the advances being made in producing integrated circuits with much higher circuit densities, the decision to emphasize the power-consumption part of the trade-off—rather than the circuit complexity—seems to be consistent with the Very-Large-Scale-Integration (VLSI) era which is just ahead.

The work in applied optics under Dändliker falls into three areas: the detection of pressure and temperature variations by optical fiber sensors, optical pattern recognition (robot-vision), and optical metrology techniques. In the first area, the group is working with Kabeloptik, a Swiss manufacturer. Two phenomena are being considered: the variation of the speckle pattern of the output light energy from a physically distorted multimode waveguide, and the change in monomode transmission caused by enhanced birefringence when a transverse mechanical force is applied to the fiber waveguide. As part of the optical-pattern-recognition project, Dänkliker and the group have implemented a hybrid Fourier-transform-based technique that uses the high-speed parallel-processing properties of coherent optical hardware (to establish two Fourier-transform planes) and the flexible characteristics of electronic processing software (to operate on the data derived in the two planes). At the output of the system, the type of object under observation, its orientation, and its location in the object plane are indicated. In the first transform plane, the power (intensity) spectrum is sensed in 2 dimensions by a rotating linear array of 720 charge-coupled diodes. The process reduces the two-dimensional pattern to a one-dimensional signature that is correlated with the entries in a library of reference signatures. This gives an indication of the type (i.e., shape) and orientation of the object but does not provide information on its location within the field of view in the object plane (because the location of the intensity spectral data in the Fourier-transform plane is invariant under linear motion in the object plane). The location data are derived by phase-sensitive measurements in the second Fourier-transform plane. This is done by using two pairs of photodetectors operating in a heterodyne system with a reference wave shifted in frequency by about 100 kHz. The photodetectors measure phase differences in a pair of orthogonal directions within the transform plane; the location of the object in its plane can be related directly to the phase shifts in accordance with the shift theorem. The 3° accuracy in phase measurement that has been achieved corresponds to a minimum displacement of the "center" of the object by about 2% in the field of view. Dändliker reported on the technique at the September 1981 meeting of the International Commission of Optics in Graz, Austria. Since then, he has been investigating the limitations on the resolution of the technique and the possibility of using multiangular illumination to resolve ambiguities between some types of objects by using three-dimensional differences.

Dändliker's work in optical metrology is probably the IMT project best known to American researchers. Before he came to the university, Dändliker was on the staff of the Brown Boveri Research Center in Baden, Switzerland. While there, he developed a number

of techniques to measure microvibrations by using speckle interferometry and to estimate internal stress and strain conditions within isotropic elastic materials from holgraphic measurements of surface deformations. The work was reported in Experimental Mechanics (March, 1979), Journal of Applied Mechanics (September, 1979), and Optics Letters (April, 1981). The watch industry's interest in quartz vibrators matched Dändliker's interests; with that industry's sponsorship, he is now generalizing his work on microvibration measurements to include a phase-measurement capability for both in-plane and out-of-plane components. The systems measure vibration with amplitudes down to about 1 nm with spatial resolution of about 30 μm.

The visit to the Institut de Microtechnique left the author with the impression that its small staff is spread rather thinly across a wide range of disciplines and projects but that it appears to be well supported in these projects by both industry and the government. IMT had been recommended by a French researcher in speech signal processing as the place to go to learn about speech-processing systems research in Switzerland. In the course of visits to various communications-oriented R&D facilities in Switzerland—including three universities, four industrial organizations, and the federal post, telephone, and telegraph laboratory—the appropriateness of that recommendation, and its understatement, became clear: no research in the areas of speech synthesis or speech recognition systems appears to be going on anywhere else in the country.

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MATERIAL SCIENCES

ADVANCED CASTING TECHNOLOGY

We are all aware of the rapid escalation in costs of military systems, with single ships now costing more than a billion dollars and single aircraft costing tens of millions of dollars. Perhaps no segment of society appreciates this more than the services themselves, which see their ability to acquire new systems eroded by cost escalation. It is no wonder, then, that attempts to reduce systems acquisition and life cycle costs are of the highest priority and involve efforts to reduce costs of even the smallest components of the systems.

To a designer of metal components or a materials engineer, one intuitively obvious way of reducing costs of complicated fabricated or machined components in new designs is to substitute cast components. Why then do we not see more evidence of such substitutions being made? This was the theme of a recent meeting on advanced casting technology for aircraft and aerospace applications held in Brussels, Belgium, on 7 to 9 April 1982, under the auspices of the Advisory Group for Aerospace Research and Development (AGARD) of NATO.

The technical sessions gave designers, the potential users of castings, the opportunity to express their needs and reservations and also provided an opportunity for the producers of castings to describe their present capabilities, to call attention to new developments, and to explain what they felt they would be able to do in the near future. There were also presentations by representatives of the research community on such subjects as management of cast structure by solidification control.

Session I, "A Review of Use and Developments of Castings," began with a presentation by D.J. Duckworth, (British Aerospace [PLC] Aircraft Group), a user of castings. Duckworth spoke of his group's experience with castings over the previous 35 years, much of it quite satisfactory. He pointed out that castings were not used more extensively for many reasons, not all of which were technical. For example, many designers continue to specify forged, machined, or fabricated parts for new aircraft because this type of processing has been used in the past and they simply are not aware of what foundries now can do. Also, designers use machined or fabricated parts in the prototype stage of a new aircraft for convenience. The parts then become frozen into the design, and customers are reluctant to spend the money to substitute castings in production models, even though overall cost savings might be demonstrated. Finally, Duckworth expressed the belief that, in the past, foundries had oversold their capabilities to users in terms of what could be cast, tolerances that could be met, and delivery schedules that could be maintained. He felt that many of the nontechnical problems could be solved by inviting designers to the foundries to make them aware of the capabilities foundries have, by more realistic attitudes on the part of foundrymen, and by getting technical representatives from the foundries together with the designers at the very earliest stages of design. If this was done, castings could be considered for use when the designers began their work and not merely as later substitutes for machined components. According to Duckworth, this substitute role has inhibited the casting process from developing its full potential.

Duckworth said that while castings were cost effective for producing complex shapes and reducing machining and assembly costs, they had several technical disadvantages. The most serious of these were the need to use obligatory casting factors in addition to normal design factors, which imposed weight penalties; the need to test cast parts more extensively than machinings, especially the expensive radiographic testing required; and the limitation on

casting size, which, he noted, was a limitation that was disappearing as a result of recent improvements in casting technology. To overcome these disadvantages, he made the following suggestions to his listeners: Investigate the production and use of larger castings where large weight savings over fabricated parts are possible; improve casting quality to eliminate or reduce casting factors required (among other things, he advocated the increased use of hot isostatic pressing [HIP] of castings to seal porosity); improve casting tolerances; attempt to reduce the amount of radiography, especially of HIP castings, by more selective specification of critical parts that need radiography; use castings of lower weight, such as magnesium alloy castings; and develop stronger cast aluminum alloys.

D. Mietrach, (VFW GmbH, FRG) presented a prognosis of the use of aluminum alloys by the aircraft industry. This was the result of a study of the current capabilities of foundries, the analysis of the economics of the casting process, and a cost-benefit analysis of different representative components. The analysis indicated that casting a typical component, which was often complex, resulted in a typical cost savings of 25% and weight savings of 20% over assembling the same component from individual machined parts. Mietrach concluded that the use of aluminum castings in aircraft would rise by about 20% during the period 1980 to 1995.

The remainder of the papers in the first session were reviews of developments in casting technology. H. Nieswaag, (Univ. of Delft, The Netherlands), presented a detailed picture of general casting processes using the flow diagram shown in Figure 1. He acknowledged that the foundryman had to control several factors

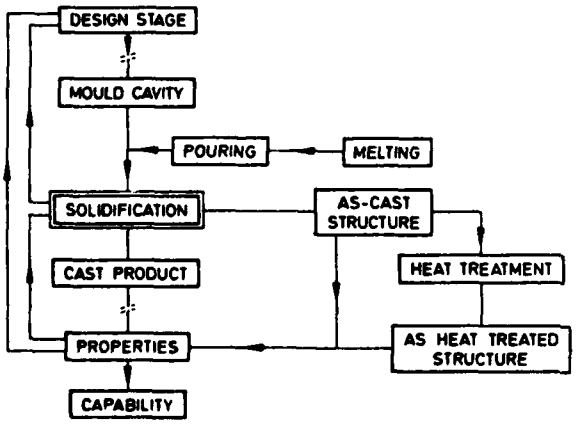

Fig. 1

to produce a good casting: mold wall instability during pouring and solidification, pickup of gases and other reactions during melting, turbulence and mold erosion during pouring, and feeding behavior. However, he said that it was basically the solidification process that governed the properties and quality of a casting. He then went on to discuss solidification processes, with particular emphasis on the intricacies of feeding practice and the adjustment of cooling rates to control structure, porosity, and concomitant mechanical properties. In addition, Nieswaag spoke about recent advancements in sand casting procedures, specifically the role of chemically bonded sands in improving the dimensional accuracy of castings.

P.H. Jackson (AICAL Ltd, UK) reviewed developments in aluminum alloy investment castings, and J.F. King (Magnesium Elektron Ltd, UK) spoke about trends in magnesium alloy castings. Jackson reiterated some of the points made by Duckworth, i.e., the designer has to be more familiar with the capabilities of foundries and the foundryman must be brought in at the early stages of design. To illustrate his point, Jackson pointed out that many property specifications still being used by designers for aluminum alloys were based on old foundry practices that dealt with sand castings. As a result, he said, properties of modern investment castings were much better than those being specified. For example, he observed that yield strengths available were 132% of specified values, while available ultimate tensile strengths and elongation values were 124% and 130% of specified values, respectively. King traced the development of cast Mg alloys over a period of 20 years and cited the development of high-strength, high-temperature, silver or rare-earth-containing alloys and high strength, zinc-rare earth alloys for hydride strengthening as being particularly significant. He also said that a lower cost, silver-free alloy would soon be available that would have higher strength and better temperature stability than many currently used Al alloys, e.g., strength of 300 N/mm^2 that could be maintained up to 250°C. King went on to talk about new developments in the casting of Mg alloys, such as fluxless melting using CO_2 plus SF_6 cover gases instead of fluxes to reduce inclusions, and the use of resin-bonded sands to improve surface quality and dimensional accuracy. Finally, he talked about treatments to protect Mg castings from corrosion but noted that there were no significantly new approaches. For example, anodic treatments such as DOW 17 and HAE are still the standard methods for applying protective films, although King mentioned other newer anodizing methods (e.g. MGZ and Magnadize) whose advocates claimed higher film build-up rates, but they had not been tested long enough for their service behavior to be evaluated. Despite recent advances in alloy technology, however, comments after King's talk made it clear that the corrosion of Mg still seriously inhibits its more widespread use. In fact, the protective coating systems themselves were mentioned as a problem area for Mg castings, because for inspections to be made for flaws in Mg parts in service, the coatings have

to be removed, and this is no mean feat in itself.

The second and third sessions of the meeting were devoted to developments in casting theory and practice. The papers reviewed methods of controlling solidification rates and solidification structures and outlined casting processes developed recently to control structure, reduce the inclusion content, and improve quality, and recent developments in cast titanium alloys.

Among the presentations related to methods for reducing inclusion content and porosity were those by M. Broihanne (Messier Fonderie d'Arudy, France) and J. Campbell (Cosworth Res. and Dev. Ltd, UK). While there were some marked differences in the processes they described, both were low-pressure sand-casting techniques that involved bottom filling of the mold to reduce turbulence and inclusions. Broihanne used gas to lift the metal, while Campbell (the GKN & Cosworth Process) pumped the metal up to the mold with a special pump with no moving parts, as shown in Figure 2.

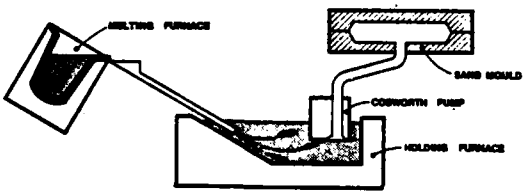

Fig. 2

The process described by Campbell was particularly interesting because of the holding furnace used to reduce oxide and nonmetallic pickup, and the use of low-expansion, high-thermal-capacity, resin-bonded sands to reduce thermal distortion and improve dimensional accuracy. Campbell claimed that in casting Al lengths of 500 mm, accuracy of better than ± 0.25 mm could be guaranteed and a repeatability of ± 0.10mm could be expected.

G. Williams (GKN Technology Ltd, UK) talked about a hybrid casting-forging process, called squeeze forming, shown schematically in Figure 3. The dies used in the process are made of hotworking die steels such as H13 and are temperature controlled to stay within the range 200 to 250°C during Al processing. This produces long die life, and Williams estimated that up to 50,000 components could be processed before die wear would become a problem. The cycle time for the process was as short as 30 s for some parts, but typical costs for processing parts were not given. The process produces parts with good surface definition, and excellent material yield is claimed. It is particularly suited to circular shapes, but more complex parts can be processed by means of split dies. So far, 20 Al alloy compositions,

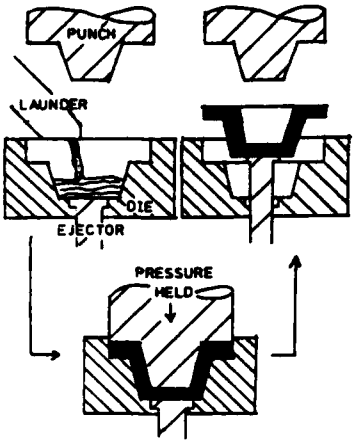

Fig. 3

both cast and wrought alloys, have been processed by squeeze forming. The cast alloys produced by the method had mechanical properties superior to those of conventionally processed castings. For example, alloy LM25 (Al-7% Si-Mg) in the as-formed condition had a 0.2% proof stress of 124 MN/mm², UTS of 195 MN/mm², and elongation of 15% compared to values of 90 MN/mm², 180 MN/mm² and 5%, respectively for a conventional casting.

In an interesting talk that illustrated how solidification control could alter structure and properties, D. Apelian, (Drexel Univ.) discussed the recently developed processes, rheocasting, compocasting, diffusion solidification (SD), and the vacuum-arc double-electrode remelting (VADER) process.

Rheocasting consists of cooling an alloy melt to a temperature at which partial solidification takes place, stirring the mushy material to break up and refine the dendrite structure, and then die casting. Among the advantages claimed for rheocasting are improved die life because of lower casting temperatures, reduced shrinkage, and easier materials handling. A variation of rheocasting is compocasting, which involves the addition of second-phase particles or fibers to a rheocast slurry to produce a composite structure upon solidification.

Diffusion solidification, as illustrated in the case of steel, consists of infiltrating a heated mass of low-carbon solid-steel particles with a high-carbon liquid iron and allowing isothermal diffusion and solidification to take place. The following are advantages of the process: a dendritic structure is avoided and there is no columnar zone, shrinkage and segregation are reduced, and casting temperatures are lowered. There are also limitations: the solid used must be of high quality in order

to assure good mechanical properties, and the technique is limited to systems in which the distribution ratio (C_s/C_l) is above 0.4.

The VADER melting process consists of horizontally vacuum melting two consumable electrodes and allowing the molten droplets to fall into a mold underneath. In research on superalloys, fine-grained equiaxed castings have been produced, in contrast to the coarse columnar-grained structures produced by the competitive vacuum arc remelt process. The mechanical properties of alloys produced by the VADER process were illustrated with alloy U718 and were particularly good, especially the ductility value, about 40% at room temperature.

In the area of titanium castings, papers by B.A. Ewing (Detroit Diesel Allison) and L.J. Maidment (MBB GmbH, FRG) were typical. Ewing described his company's development of investment-cast compressor impellers and concluded that the use of cast titanium components, rather than machined forgings, could bring significant cost reductions, that the state of the art of casting Ti had advanced significantly over the past few years, and that new alloys and processing concepts should improve the fatigue performance of cast Ti components, something that is of great concern to designers. Maidment spoke about his company's investigation of the use of centrifugally cast Ti-6Al-4V alloy for a helicopter rotor head. He pointed out that, while the fatigue endurance limit of the cast alloy is only 63% of the wrought alloy value, an acceptable component fatigue life could conceivably be obtained by minor design modifications of the rotor head. He also noted that the 15% reduction in machining costs achieved by using a casting rather than a forged part did not, in itself, make a casting a viable alternative. On the other hand, he felt that improvements in the centrifugal casting technique of titanium would lead to alloys with improved structure and properties and make them competitive with machined parts in aerospace applications.

The final session of the meeting was concerned with casting practice and quality control. C. Liesner (TITAL, FRG) discussed the philosophy of quality assurance and the conflict between the user, whose demand for more reliable parts was increasing due to more stringent liability laws, and the producer, who had to consider the economics of the situation. He gave examples of quality assurance procedures relevant to aluminum and titanium castings. J. Thiery (SNECMA, France) talked about defects in steel and superalloy castings for turbojet engines and methods of detection and correction. S. Kennerknecht, (Cercast, Canada) concluded the session with a review of the metallurgical variables that influence the production of quality investment castings.

The meeting and the papers presented, which will be published later as an AGARD-NATO document, provided an excellent review of the state-of-the-art of casting technology, especially as related to the aerospace field. The sessions brought out many of the reservations held by designers with respect to cast parts and illustrated the roadblocks, many of which were not technical, faced by the casting industry in its attempt to get the aerospace industry to use more castings. They also brought out the fact that some significant advances had been made in casting technology over the previous decade or two, especially with respect to casting quality, dimensional accuracy, and the complexity of parts that could be produced. Some of the key points the author got from the meeting were:

(1) There is a great need to get foundrymen and designers together at the earliest possible point in the design of new components and to effect an open, working partnership between them.

(2) To make better use of current casting technology, it is desirable to design components from the beginning as cast parts rather than to use castings as substitutions for machined or fabricated parts later.

(3) Porosity is still a serious problem. Many look to hot isostatic pressing (HIP) as a solution in many cases, e.g., Ti alloys. Others consider the need to use HIP as a failure of the casting process and another added cost factor.

(4) The problem of obtaining test bars to determine the mechanical properties of a casting is a serious one. The use of integral test bars adds costs to the casting, and the question still exists as to whether properties of the test bars are representative of those of critical parts of the casting. The question is especially valid in the case of separately cast test bars.

(5) While recent advances in casting technology have improved the situation, thin sections still present a problem.

(6) Some of the newer casting processes or hybrid casting processes offer unique opportunities for microstructural modification and property control. At present, it is difficult to determine whether costs will be competitive.

Whether the meeting accomplished the objectives of its initiators only they can say, but it was certainly a step in the right direction.

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ONR London

MATERIALS ENGINEERING AT THE TECHNION - ISRAEL INSTITUTE OF TECHNOLOGY

As previously noted in these pages, Technion, the Israel Institute of Technology, is the premier engineering school in Israel. The Department of Materials Engineering, established in 1968 as part of the faculty of Mechanical Engineering, offers materials-related courses within the Mechanical Engineering Faculty and other engineering faculties but does not grant undergraduate degrees. At the graduate level, however, both MSc and DSc degrees in materials engineering are offered; there are about 80 graduate students enrolled. Prof. Ben-Zion Weiss is head of the department, which includes a staff of 17 full-time, 25 part-time, and 9 adjunct members. Materials research, which covers a broad spectrum, is supported by both the state (about 55%) and private sources, some of which are outside Israel.

Profs. David Brandon and Elazar Gutmanas are collaborating in research on high-technology ceramics for strength and wear applications. This is a relatively new effort; in the past most interest in ceramics has been confined to traditional ceramics. The present research seeks to determine the effect of microstructure on mechanical properties and to learn how to tailor microstructures to improve those properties. Three projects are now in progress. The first is a study to improve the mechanical properties of AD-85 Coors alumina. This alumina contains a glassy phase that promotes densification at lower temperatures. The glassy phase surrounds the alumina particles and is considered to be a source of defects and weakness. Brandon and Gutmanas are trying to improve the strength of this composite material by heat treatments that alter the morphology of the microstructure and the distribution of microstresses within the structure. So far, they have determined that heat treatment, especially controlled cooling, can increase strength by as much as 150%, although increases of 40 to 60% are more usual. At the same time, the fracture toughness can be raised by a factor of 3, from 3 to 9 MPa $m^{\frac{1}{2}}$. Brandon feels that these improvements are due to a redistribution of microstresses within the composite structure rather than to surface effects, which some investigators have proposed. In another interesting aspect of research on this material, Gutmanas has used indentation tests to show how the loading rate can affect fracture properties by causing a change in crack path. For example, as the loading rate increases, the crack path changes from one that follows the glassy phase alone to one that cuts across both the glassy and alumina phases. The results of this work will be presented at a technical meeting in Australia later this year.

In another project, Brandon is studying transformations at low temperatures in partially stabilized zirconia. The impetus for this investigation stems from practical work involving the shrink fitting of zirconia liners for diesel engines. Brandon observed that when ZrO_2, stabilized with either MgO or both MgO and CaO, was held at liquid nitrogen temperatures for a period of time, diffuse scattering was observed in x-ray patterns. He feels that what he is seeing is an isothermal martensitic transformation of the cubic phase that has never been observed before.

The third project, which is just getting under way, concerns the use of chemical vapor deposition (CVD) of ceramic coatings on tools to improve wear resistance. Coatings such as TiC, TiN, and Al_2O_3 on tungsten carbide tools will be studied. Brandon noted that previous investigators of wear of coated tools concluded that much of the wear is due to chemical reactions between the coating and the surface of the metal being machined and that wear is often a function of the morphology and grain orientation of the coatings. He spoke of his plans to investigate this aspect further in the new project.

In addition to his collaborative efforts with Brandon, Gutmanas is conducting research on compaction of powders at very high pressures. Over the past several years, he has shown that when one pressed powder compacts at a pressure of about 2 to 4 GPa, which is 5 to 10 times the customary pressure, not only are high densities achieved (>95%), but a great deal of cold welding takes place between particles. Thus, compacts with high strengths are produced that can be further strengthened to their full potential by relatively low temperature sintering treatments. For example, stainless steels pressed at high pressures can be sintered satisfactorily at temperatures of only 1,000°C compared to temperatures greater than 1,300°C required for conventionally pressed material. Gutmanas feels that savings achieved by sintering at lower temperature may outweigh the increased die costs and longer pressing cycles dictated by high-pressure compaction. In addition, he feels that high-pressure compaction would be particularly suited for processing composites in which one is attempting to minimize interactions between components, for composites containing a component that thermally decomposes at high temperatures, or for processing materials that would experience unwanted phase transformations at high processing temperatures. Some examples of these would be metal-bonded diamond composites, metal-intermetallic composites, and metastable or amorphous materials.

Prof. J. Yahalom, recently returned from sabbatical leave in the US, is reconstituting his research programs. He is interested in thermogalvanic processes wherein the anode and cathode are at different temperatures. He is motivated by the desire to provide improved solar energy conversion systems, which are particularly applicable in Israel, where housetop solar hot water systems can be seen in profusion. He would also like to continue his investigations of how surface energy affects critical potential for pitting, some aspects of which he reported at the last international conference on passivity in Airlie, Virginia. Yahalom is also interested in continuing research on pulse plating to enhance deposition rates and lower hydrogen pickup, research on modulated structures produced by periodically altering potentials of plating baths, and research on the interaction of laser radiation with plating systems to enhance deposition rates and to provide means for selective deposition.

Prof. Y. Komen is working on interfaces, thin films, and electronic materials. Much of his research involves transmission electron microscopy investigations of interfacial structures produced by processing. Recently, for example, he was involved in an investigation of the nature of the interface of explosively bonded materials. According to Komen, just finding the interfaces of explosively bonded materials is a formidable task; to simplify the experimental difficulty, single crystals were used. One of the interesting discoveries was the close resemblance of the structure at the interface to thermomechanically treated material. In most cases, Komen found signs of recrystallization at the interface, but he was unable to determine whether this was due to dynamic recrystallization or was a result of working and annealing by the shock and thermal waves inherent to the explosive bonding process.

Komen is also working with silicon thin films. He has been investigating recrystallization behavior in order to effect conductivity changes. His technique consists of depositing polycrystalline films, irradiating the films to produce an amorphous structure, and then annealing them to get recrystallization and grain growth. While doing this, he observed an interesting "memory effect" wherein irradiated amorphous films recrystallized upon heating and reverted to the grain size they had before irradiation. The effect seemed to hold as long as the irradiation level that produced the amorphous structure was below a certain level. Komen speculated that this behavior might provide a clue as to structural rearrangements in the amorphous state or to the amorphous state itself, as defined by conventional x-ray evidence.

Finally, Komen is studying the changes of electrical and electronic properties of thin films as a result of gas adsorption to produce selective solid-state gas detectors. He hopes to continue some aspects of his research programs at the IBM Research Center, where he will soon be spending his sabbatical leave.

Prof. I. Minkoff was unavailable at the time of the author's visit, but F. Ornath, one of Minkoff's PhD students, outlined ongoing research on steel armor materials and ballistic deformation and fracture of steel armor. Ornath has been studying microfracture processes and the role of microstructure on dynamic fracture processes for his doctoral research. Ballistic testing is carried out for Ornath by Rafael, the Israel Armament Authority. Among other things, his research has again confirmed the importance of microstructural cleanliness to high-quality steel armor and the role that inclusions play as initiation centers in dynamic fracture processes. For this reason, and because Israel has no facilities for producing rolled armor, Ornath is particularly interested in studying materials produced by processes such as argon-oxygen decarburization. This process, which is capable of producing high-quality steel, is a casting operation that can be handled more easily by a foundry than can processes such as electroslag remelting or vacuum casting.

Prof. S. Direnfeld's fields of research are phase transformation, mechanical properties at high temperatures, powder metallurgy, and unidirectional solidification. In the last-named area he has developed a particularly versatile facility for producing unidirectionally solidified materials. His current investigations involve nickel-based alloys, and he recently completed research on unidirectionally solidified Ni-W alloys for the German "NASA", DFVLR, Köln, FRG.

A unique feature of the Department of Materials Engineering at the Technion is its collocation with the Israel Institute of Metals, headed by Mr. S. Golan. The institute, which is concerned with industrial research and development, employs about 50 people, about half of whom have academic degrees. It is operated jointly by the Technion Research and Development Foundation Ltd. and the Ministry of Industry, Commerce, and Tourism. About 5% of its operational expenses are met by the government, while the remainder are paid by means of contracts with industry and public institutions. Half of the contracts are developmental, 30% are short-term consulting contracts, and 20% are devoted to testing. The activities of the institute are broad, as revealed by the names of the laboratories within it: metallurgical, foundry, vehicle and mechanical engineering, corrosion and metal finishing, nondestructive testing, and welding. The institute is a separate entity from the Materials Engineering Department but shares some equipment and conducts mutual research, and some staff of the institute serve as adjunct staff members in the department.

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MATHEMATICS

THE 7TH ADVANCES IN RELIABILITY TECHNOLOGY SYMPOSIUM

The Seventh Advances in Reliability Technology Symposium was held at the UK's University of Bradford during the period 14 to 16 April 1982. The meeting was cosponsored by the University of Bradford and the National Center of Systems Reliability, Warrington, UK. Dr. A. Z. Keller, chairman of the School of Industrial Technology at the University of Bradford, was the conference chairman. The symposium was generally slanted toward the reliability engineer rather than the reliability theorist. Thus, most of the papers (possibly 25 of the 35 presented) were concerned either with design and maintenance of installed hardware systems or with reports of the assessment of reliability of installed systems. Two typical titles were "Valves and Pumps Operating Experience in French Nuclear Plants," by J.R. Aupied, A. Le Cogniec and H. Procaccia (Electricité de France, Etudes et Recherches, Saint-Denis, France) and "Failures and Maintenance Data Analysis at a Petro-chemical Plant," by D.J. Sherwin (Dept. of Engineering Production, Univ. of Birmingham, UK).

Throughout the symposium, there was emphasis on how to perform reliability analyses, including collection of the necessary data, modeling the failure processes of the systems under consideration, and performance of statistical analyses on the data collected. The use of reliability standards by the engineering community was also discussed frequently. For example, several attendees expressed doubts about the validity of currently available failure standards for large-scale integrated-circuit (LSI) chips. The published standards were based on early failure experience with such chips. Recent experience has shown that many types of LSIs now on the market are more reliable than is indicated by the early standards data.

In the maintenance of highway lighting, the UK Department of the Environment has considered various alternatives to the two basic maintenance policies of periodic block replacement and individual replacement on failure. The department is investigating the benefits of a block replacement policy, as compared to individual replacement on failure. Individual replacement is more costly because the slow lane of the road must be blocked off for approximately a mile on either side of the point at which the lamp replacement work is taking place. Following a study of the amount of illumination needed on the roadway, a policy was suggested under which replacement would be made only when r lights in a row had failed. Two papers gave the flavor of this kind of research. The first, "A Statistical Model of the Failure of Motorway Lamps," by M.J. Newby (School of Industrial Technology, Univ. of Bradford) concerned the distribution of the number of individual lamps in a block that have failed when a line of r motorway lamps is classed as failed. The distribution of the time to system failure (r in a row failed), given the distribution of failure times for the individual lamps, was also considered. The second paper, "A Motorway Lighting System Maintenance Model Based on Simulation," by D.M. Barry (Dept. of Electrical Engineering, Lakehead University, Thunder Bay, Ontario, Canada) and R.J.F. Gorty (G.E.C. Machines Ltd., Preston, Lancaster, UK) discussed replacement policies for highway lighting. The authors presented the results of a computer simulation of the expected unit costs for different maintenance policies of roadway lighting. They explained that the 200-watt linear low-pressure sodium lamps commonly used along roadways in the UK follow a bimodal failure distribution; an almost constant underlying failure rate is exhibited up to approximately 5,000 hours, after which the wearout failure rate predominates. The simulation model used a bimodal Weibull distribution for individual lamp life. The results indicated that the three-in-a-row policy is considerably cheaper than simple bulk replacement, with savings on the order of 40%. It was also found that various other r-in-a-row replacement policies were cheaper than block replacement policies.

In his paper, "Quantitative Risk Analysis in the Design of Offshore Installations," Dr. J.E. Vinnem (Norwegian Inst. of Technology) described a method for performing risk analyses. Accident statistics from offshore-drilling-platform operations show there is substantial risk for personnel and equipment. This implies that there should be a systematic approach to the management of risk in the design and use of such platforms. The Norwegian Petroleum Directorate (NPD) recently issued guidelines for safety evaluations of platform design concepts. The guidelines address the problem of total risk evaluation for drilling platforms, wherein the basic concept is to consider both the probabilities of various types of accidents and the consequences of such accidents. This contrasts with reliability analysis, which is essentially concerned only with the failure probabilities. Once a risk "budget" has been established (based in part on past experience with similar systems), it is often possible to make design tradeoffs in an attempt to meet the risk goals. For example, suppose a platform under design is required not to exceed a mean fatality rate of 0.1 fatalities per year. The designer may have to consider the contributions of such factors as operational policies, platform hardware configurations, and platform safety systems to the predicted fatality rate of the platform.

According to Vinnem, a logical procedure for analyzing accident events should include the following steps: (1) definition of accidents of various types and identification of their consequences; (2) analysis of influences of safety

systems; (3) analysis of influences of environmental factors; (4) analysis of possible "escalation" to other accidents as a result of a given accident; (5) estimation of event probabilities; and (6) analysis of risks, based on the set of factors contributing to an accident event, taking into account passive safety systems. Carrying out such analyses is not an easy task, so it is significant that Norway has mandated that these assessments be made as part of the industrial design process.

An interesting approach to simulating hardware for reliability evaluations was presented in the paper, "The Development of a New Hardware Reliability Simulator," by N.D. Deans and D.P. Mann (Robert Gordon Institute of Technology, Aberdeen, Scotland). Deans and Mann have developed a stochastic reliability simulator based on Monte-Carlo simulation techniques that allows the reliability of complex systems to be studied. Each component of the system is modeled by a separate microprocessor. By allowing the modeling of each component to proceed simultaneously with all other components, a high degree of parallelism can be achieved. This, together with the use of asynchronous time-scaling techniques, has yielded operational speeds of the order of 10^8 computations per second. Deans and Mann have used their device to simulate complex unreliable systems. They found that, typically, accumulated system times of 10^7 hours are simulated by their equipment in approximately 1 second. For reliability evaluations of acceptable accuracy, such an analysis carried out on a digital computer with a von-Neumann architecture usually necessitates much longer computation times, according to the Aberdeen experience.

A block diagram of the Aberdeen simulator is shown in Figure 1.

The analysis requires a number of subsystems acting under control of a host computer. The host computer initializes the microcomputers representing the components in the system being simulated. This involves sending out information on the "control bus" about such things as the failure and repair distributions of each component, the structure of the system, details of replacement policies, start-up delays, and start-up failure properties for each component. The host computer then relinquishes control of the simulator and the latter proceeds to act autonomously. Individual components operate in a united fashion, each processing random number distributions for simulated failures and repairs. A statistical gathering module collects data related to the behavior of the system model, as well as performances of specified subsystems; the module acts as a "statistical probe". Subsequently, the host computer processes the data and generates summary reports on the simulation.

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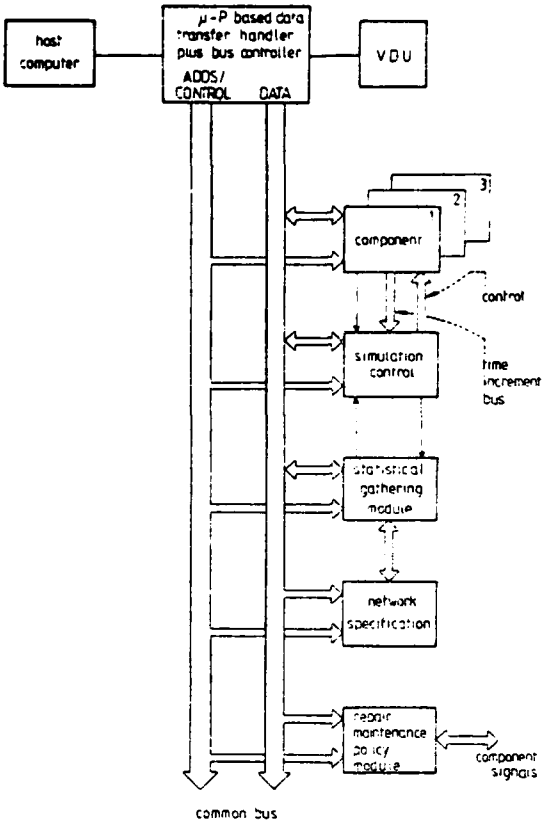

Fig. 1

THE EUROPEAN INSTITUTE FOR ADVANCED STUDIES IN MANAGEMENT

The European Institute for Advanced Studies in Management (EIASM), in Brussels, Belgium, is an organization dedicated to a variety of research-related activities. The institute's general objective is to improve the quality of management science research in Europe. This article reviews some of the activities as reported to the author by EIASM's director, Dr. Philippe Naert.

In order to get a clear picture of the raison d'être of EIASM, it is useful to review some of the historical circumstances surrounding its development. Britain, of course, has always been at the forefront of management science. But during the 1960s, other European countries began to take research in management science seriously, and a number of European governments and private institutions initiated programs to send students abroad (primarily to the US) for graduate study in management science. Individuals returning to their respective countries with PhDs in management science often had a major impact on management science

education and research in Europe. But frequently they did not find the necessary environment to support or even encourage their research interests, so their initial enthusiasm for research tended to subside, and often after a few years they found themselves again behind the research frontiers of their specialities. Thus it appeared that although much had been invested in preparing people for research careers and that the investment promised high initial returns, these, unfortunately, tended to depreciate very rapidly. In addition, as professional contacts tended to be related to the sites of their graduate studies, there often was little communication among the European researchers.

This situation led to the creation of EIASM in 1971. In its early years, the institute tried to improve the quality of management science research in Europe primarily by assisting European doctoral students. It was financially supported by Belgium, France, The Netherlands, and Sweden, and also received significant funding from the Ford Foundation. In the mid 1970s the activities of the institute were broadened to include work with faculty members in European management science departments. The Ford Foundation "seed" support had terminated by then, but Denmark, Finland, Ireland, and Norway had joined the supporting countries. (Because EIASM is a private institution according to Belgian law, the Federal Republic of Germany has never officially supported it. However, Germany has given the institute unofficial support and has sent students and faculty to study there.)

The activities of the institute fall into four categories: a program of meetings, a doctoral fellow program, network development, and research. These activities are carried out by the EIASM faculty, which is not a permanent body but changes continuously. Most faculty members are at the institute for periods ranging from 3 months to a year. Many are on sabbatical leave or leave of absence from their regular institutions, and several are there on a part-time basis. The 1981-82 faculty members, their institutional affiliations, and their areas of research interest are as follows:

H.I. ANSOFF	EIASM/Stockholm School of Economics - Strategic Management
C. BECKERS	Vlaamse Economische Hogeschool, Brussels - Finance
A. BULTEZ	Facultés Universitaires Catholiques de Mons - Marketing
H. DAEMS	Universitaire Faculteiten St Aloysius, Brussels - Industrial Economics and Public Policy
Th. FALK	Stockholm School of Economics - Marketing
P. JOYNT	Norwegian School of Management, Oslo - Organizational Behavior
C.R. JULANDER	Stockholm School of Economics - Marketing
K. MÖLLER	Helsinki School of Economics - Marketing (second semester)
Ph. NAERT	Director of the European Institute, Universitaire Faculteiten St Ignatius, Antwerp - Marketing
M. PADBERG	New York University - Management Science
J.M. PROTH	Université de Metz - Management Science
A. RINNOOY KAN	Erasmus Universiteit Rotterdam - Management Science
H. SCHREUDER	Vrije Universiteit Amsterdam - Accounting
L. SJÖBERG	University of Göteborg - Psychometrics
B. SØRENSEN	Odense University - Finance (first semester)
R. STAPLETON	Manchester Business School - Finance
M. THARAKAN	Universitaire Faculteiten St Ignatius, Antwerp - Development Economics
J. THEPOT	Université de Paris-Nanterre - Economics of the Firm
R.A. THIETART	ESSEC Cergu - Strategy

Each year the institute organizes approximately 25 meetings, including workshops (1- or 2-day events during which research in progress is presented), seminars (state-of-the art presentations), tutorials (presentations by advanced doctoral candidates of their research), advanced courses (presentations by acknowledged experts of the recent advances in their areas) and methodology courses (2-week courses on how to conduct research in various areas). On the day the author visited EIASM, for example, a 3-day advanced course on macro-organizational design using decomposition and simulation was being presented to some 30 attendees by Profs. Richard M. Burton (Duke University, Durham, NC, USA) and Børge Obel (Odense University, Denmark). Table 1 on the following page, shows the activities in the meetings, by area, during the past 4 years. The majority of the participants in institute meetings come from Belgium, France, Germany, the Netherlands, the United Kingdom, and the Nordic countries.

The doctoral fellow program is aimed at giving assistance and advice to doctoral candidates. This includes initial research guidance for a large number of beginning doctoral students, as well as research supervision of a limited number of doctoral fellows (about 10 admissions per year) throughout their studies. As the institute is not a degree-granting establishment, the doctoral fellows are doctoral candidates at "home" universities. This often allows a doctoral candidate to obtain active research supervision from a visiting institute

Table 1. Number of activities by area

Year:	77-78	78-79	79-80	80-81
Accounting and Control	3	2	2	-
Finance	5	5	5	7
Organization Behavior	7	3	3	4
Management Science	1	3	2	10
Marketing	3	4	3	3
Strategic Management	4	5	4	3
Others	3	2	2	5
Total number of activities:	26	24	21	32
Total number of participants:	902	816	796	809

specialist; such expert supervision sometimes is not provided to PhD students in European universities.

The European Institute promotes the creation of networks of communication among researchers in different domains by bringing them together in workshops, seminars, and intensive courses. In addition, it has helped to create and is actively involved in a number of professional associations, including the European Accounting Associations, the European Academy for Advanced Research in Marketing, the European Finance Association, and the European International Business Association. It also has close working ties with the Association of European Operations Research Societies (EURO) through the EURO working groups representing research areas of interest such as mathematical programming, fuzzy sets, education in operations research, and energy modeling.

Research is not only stimulated and disseminated at the institute, it is also produced in a volume that is quite respectable, given the size of the faculty. A fair amount of the research is applied. The institute publishes about 50 working papers per year. Information about the papers is available in a monthly newsletter. In addition, faculty members are regular contributors to a variety of scientific journals, many of which are published in the US. Besides conducting their own research, faculty members are encouraged to participate in doctoral research supervision, workshop presentations, and collaboration with other faculty members on selected issue-oriented projects.

Naert's busy schedule serves as an example of faculty activities. After receiving a PhD from Cornell in Quantitative Economics and spending a year at MIT, he joined the Applied Economics Department of the University of Antwerp in 1973. In addition to fulfilling his many duties as director at EIASM, Naert carries a full teaching load at the university, where he has five PhD students working under his guidance. He is interested in marketing and is the author of the book Building Implementable Marketing Models and of several journal articles written on the subject in recent years. For the most part, the articles have appeared in journals published in the US, including the Journal of Marketing Research, Management Science, and the Journal of the American Statistical Association. Since US readers are probably familiar with these papers, they are not reviewed here. It is relevant to observe, however, that, even though these papers typically include a fair amount of theoretical development, they almost always contain "empirical substantiation" through applications to actual market data.

In summary, EIASM has evolved into a role useful to its supporters. The institute might well serve as a model for providing research support in various contexts, for example, in developing countries. Naert's energetic and enthusiastic leadership is promoting activities that are consistent with the European outlook and methods. "The institute is no longer trying to adapt itself and its activities to the US mold," says Naert. The institute is small but active, and it appears to be quite cost effective. For US management science faculty members contemplating a sabbatical leave, a tour of duty at EIASM is certainly worth considering.

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PHYSICS

SOLID STATE PHYSICS AT THE AUTONOMOUS UNIVERSITY OF MADRID

The Autonomous University of Madrid, Spain, was founded in 1968. The name implied a larger discretion in choice of research and faculty than was possible under the regular state-supported university system. Originally the faculty was hired by contract rather than by the more traditional tenure system. Prof. N.F. Cabrerra, well known to many Americans from his years in the US, was instrumental in shaping the university and until recently was dean of the faculty. Cabrerra told the author that the university, with 20,000 students, is less autonomous now than it was originally but that it is still prominent in research.

The Physics Division includes five groups whose research interests, especially in the field of surfaces, often coincide. Cabrerra and N. Garcia have collaborated on a study of scattering from a periodic hard surface (Phys. Rev. B. 18, 576 [1978], Phys. Rev. B. 18, 5184 [1978]); Garcia has published several other papers on scattering (Phys. Rev. Lett. 37, 912 [1976], Phys. Rev. B. 18, 970 [1978]; Surface Sci. 71, 220 [1978]). Much of Garcia's has work dealt with the scattering of neutral atoms (He) from the corrugated potential of the outermost atomic layer of the solid. The potential used was a combination of a hard-sphere

Pauli repulsion and a Van der Waals attraction. Garcia was primarily interested in the convergence of computational methods for deeply corrugated surfaces.

In another effort, Garcia and G. Benedek (Surface Sci. 103 L143 [1981]) analyzed the time-of-flight spectra for He scattered from the (100) face of LiF. Using the hard corrugated surface approximation, the authors showed that the structures observed were a result of the phonon density near the surface. The differences between the theoretical calculations and the experimental results were thought to be attributable to bound states.

As an outgrowth of the atom-surface scattering work, Garcia collaborated in calculating the modification of the scattered intensity through the exchange of energy between the incoming particle and the vibrations of the lattice. With A.A. Maradudin (Univ. of California, Irvine), he determined the Debye-Waller factor for the scattering of atoms from a flat hard surface. Using a continuous phonon spectrum containing longitudinal, transverse, and Rayleigh waves, the two men found that the effective mean square displacement of the atoms was significantly reduced (by ½ at surface temperatures above 100°K) without taking the finite size of the incident atoms into account. The calculations covered all temperatures and angles of incidence, and in some cases the Rayleigh waves were found to be the major contributor.

Garcia is also interested in the nucleation of solids. In 1981 he published the results of a Monte Carlo calculation for argon (Phys. Rev. Lett. 47, 186 [1981]). Using a Lennard-Jones potential, he and J.M.S. Torroja calculated the free energy and homogeneous nucleation rates of argon clusters. The results were in agreement with experiments over a wide range of temperatures and pressures.

The experimental group is headed by J.M. Rojo, who came to Madrid in 1971 after studying crystal defects at Cambridge University. In the past (Phys. Rev. B 13 4348 [1976], Surface Sci. 64 668 [1977]) Rojo measured the effects of various adsorbates on transition-metal surfaces with Auger electron spectroscopy (AES). More recently, he used AES to determine an enhancement of oxidation of an Ni surface after bombardment with A ions (Solid State Commun. 35 83 [1980]). The damage from ion bombardment extended through several layers and was thought to provide a larger number of oxide nucleation sites than the undamaged surface. In another paper, Rojo discussed the enhancement of oxidation on a Pt surface (J. Chem. Phys. 72 6614 [1980]). Very low doses of ions were found to produce large changes in the concentration of oxygen on the surface, an effect that did not seem to come from the formation of point defects. Low-energy electron diffraction (LEED) studies of the surfaces showed a rearrangement after the ion bombardment.

J. Ibanez, a PhD student, has been working with Rojo and Garcia on a study of absorbate layers using neutral atom (He) scattering. The intensity of the beam scattered from an Ni (100) surface with a low concentration of O and CO atoms was observed to oscillate with the angle of incidence. Ibanez used a simple model to gain information about the corrugated potential and the distribution of charge.

In 1978 and 1979, A.M. Baro was a visitor at the Kernforschungsanlage, Jülich, FRG, where he published the results of electron energy loss spectroscopy (EELS) studies of adsorbates on Pt. Using an instrument with a resolution of 7.5 mev (60 cm^{-1}), Baro and H. Ibach (Kernforschungsanlage, Jülich) determined the absorption of CO (J. Chem. Phys. 71 4812 [1979]) and of H (Surface Sci. 92 237 [1980]). The two scientists found a new vibrational mode for CO that they attributed to the C-Pt asymmetric stretching vibration, which becomes active as a result of an out-of-register overlying structure of CO formed at large CO coverages. They also observed H-Pt symmetric stretch vibrations and proposed a stepped-plane model of H absorption to account for the observations. Baro is preparing a research program to continue this type of work.

The low-temperature laboratory, headed by S. Vieira, includes several operating ^4He cryostats; a ^3He cryostat is under construction. In collaboration with R. Villar and M. Hortal, Vieira developed a cell for low-temperature thermal expansion measurements (Rev. Sci. Inst. 51 27 [1980]) that was used subsequently to determine the thermal expansion of single-domain and polydomain $NaNO_2$ parallel to the ferroelectric b - axis (Solid State Comm. 41 103 [1982]). Below 10°K an additional contribution is present for a multidomain state that is thought to arise from the presence of domain walls.

In 1980, Villar was a Humboldt fellow at the Max-Planck-Institut in Stuttgart. During that period, Villar, Vierira, and E. Gimelin measured the low-temperature specific heat of single domains and polydomains in $NaNO_2$ at temperatures ranging from 2 to 40°K. The specific heat of the single-domain material was found to follow a Debye T^3 law; the polydomain data were accommodated better by including a term of temperature dependence between T and T^2, ascribed to domain walls. Vieira and his colleagues also measured the low-temperature pyroelectric behavior of $NaNO_2$ (Ferroelectrics 33 13 [1981]) and found that the temperature dependence of the charge released is the sum of three terms: a small term with temperature dependence between T and T^2, a term proportional to T^4, and one proportional to $e^{-\Theta/T}$. The T^4 term is negative and arises from the thermal deformation; the exponential term is positive and is thought to be the result of low-lying optical modes. The findings are similar to those for KDP except that the

positive and negative contributions are more clearly defined in $NaNO_2$. Vieira has carried out similar measurements on $LiNbO_3$ (Ferroelectrics 24 101 [1980]). He is preparing a paper for publication in Physical Review B on the spontaneous polarization of $LiNbO_3$ below 50°K.

The Department of Optics and the Structure of Matter is under the direction of F. Agullo-Lopez, who joined Canto Blanco from Brookhaven National Laboratory, Long Island, New York, in 1970. Agullo-Lopez said that the department's principal interest is the study of defects in solids by optical methods. Pure and doped alkali halides have received special attention. Luminescence and recovery processes after x-ray irradiation at low temperature have been studied in NaCl (Solid State Commun. 34, 869 [1980], 36, 1001 [1980]; Phys. Rev. B. 23, 3041 [1981]); and in NaF (Phys. Stat. Sol. 102, 595 [1980]) by observation of absorption spectra and electron spin resonance (ESR). The department has calculated the location of the impurity levels that act as electron or hole traps by means of a simple Born-Haber model (Crystal Lattice Defects 9, 131 [1981]). It has also measured the optical absorption of x-ray-induced color centers in NaCl doped with Mn (J. Phys. C. Solid State Phys. 12, 1221 [1979] and photoemission of color centers in RbCl produced by electron irradiation (Phys. Stat. Sol. A58, 219 [1980]). In addition, Agullo-Lopez and his colleagues have published papers on various aspects of radiation coloring: interstitial motion (Phys. Stat. Sol. B97 575 [1980]), the role of impurities (Radiat. Eff. Lett. 50, 79 [1980]) and a heterogeneous nucleation model (J. Phys. [Paris] 41, C6-341 [1980]). Luminescence in other materials, particularly $BaTiO_3$, has also been studied (Ferroelectrics 25, 467; 25, 511; 29, 135; [1980]).

The department is carrying out applied research relating to the optical radiation damage of Perovskitas and thermal damage in solar-energy-device materials. A luminescent solar concentrator is a transparent material containing a luminescent center that, by absorption and reemission, converts part of the solar spectrum into wavelengths better matched to the response of a photovoltaic cell. Degradation of the transparent material occurs by optical bleaching and thermal damage. F. Cusso has collaborated with other departments of the university in measuring thermal damage in polymethylmethacrylate doped with Rhodamine B and Rhodamine 6G (J. Power Sources 6, 383 [1981]). In such materials the height of the absorption and luminescent emission peaks decreases in time at elevated temperatures (94°C). After the initial decrease there is a partial recovery and a subsequent approach to a plateau. A series of thermal cycles tends to decrease the plateau montonically so that, as the authors point out, "It is necessary to be careful to avoid the superposition of thermal degradation in optical damage measurements."

J.R. Neighbours

Naval Postgraduate School
Monterey, CA

SOLID STATE PHYSICS AT THE UNIVERSITY OF VALLADOLID

At the time of the author's visit to the University of Valladolid, Spain, the Department of Thermal Sciences had a new head, Prof. A. F. Tejerina, formerly of the Autonomous University of Barcelona. Tejerina had not yet arrived, but M. A. Villamanan, a postdoctoral research associate, spoke about his work, which deals principally with membranes. Tejerina has collaborated with others in measuring the Onsager cross coefficient L_{21}, relating the current flow across a porous sintered glass membrane to the pressure difference (J. Non-Equilib. Thermodyn. 5, 103 [1980]). The current across the membrane cannot be measured directly; therefore, the current in the external circuit (a resistor) is measured. The membrane current is the sum of the external current and the polarization induced in the liquid being used. Investigations with a dielectric fluid (dimethylketone) and an ionic fluid (0.01 M KCl solution) have shown that, for small membrane currents (0.01 A to 1 A), the current is linear with pressure difference and gives L_{21} from the slope. Other experimental work on the determination and characterization of membranes is also contained in Volume 5 of the above journal.

Tejerina has done theoretical work on quantum transport through membranes (Int. Journ. Quant. Chem. 17, 1191 [1980]) in which the membrane is considered as a potential barrier and transmission (flow) occurs only as the result of energies greater than the barrier height. That is, under the usual conditions the tunneling effect through the barrier is considered negligible. The model has been extended to a smooth monotonically changing barrier (Letter Nuovo Cimento 29 462, [1980]). A full development of the model as an analog for irreversible thermodynamics is to be published in Nuovo Cimento. Tejerina plans to continue the theoretical work and to initiate studies of the excess enthalpies and entropies of mixtures.

Villamanan recently finished studies in France (Univ. of Clermont), where he performed flow calorimeter measurements of the molar excess heat capacities of alcohol-aliphatic ether mixtures. The results, which add to the data base of a project on the thermodynamic functions of liquid mixture, are to be published in Thermodynamic Acta (1981) and the Journal of Chemical Thermodynamics (1982). At Valladolid, Villamanan and Tejerina will cooperate

in setting up a laboratory for continuing such measurements.

Prof. J. A. de Saja, the director of the Laboratory for Solid State Physics, was away when the author visited, but his wife, A. de Saja, who also works in the same laboratory, spoke about activities there. Raman spectroscopy, the principal tool, is used to study crystals, polymers, and liquid water; OH bonding and the structure of the bonds are the main topics of interest. The polymer studies are being done in collaboration with the Spanish Research Council in Madrid, which provides the samples, principally polyvinyl and polyethylene. A recent letter (Polymer 20, 780 [1979]) describes the results of a Raman spectroscopic experiment on polyalkenamers that contain methylene sequences and therefore have a structure similar to polyethylene and paraffins. In normal paraffins, C_nH_{2n+2} Raman spectroscopy shows the presence of a longitudinal accordion mode (LAM) whose frequency varies as n^{-1} and gives a measure of the thickness of the chain folded lamella crystals. In the polyalkenamer, no LAM corresponding to the thickness of the lamella was observed. Instead, a band corresponding to LAM vibrations of the repeat unit CH = CH - (CH_2)m was found that led the authors to conclude that the LAM may be decoupled by double bonds.

Much of the work in the laboratory deals with hydrated crystals containing the lanthanides. They are grown from an aqueous solution by slow, programmed heating. The compound $La_2(SO_4)_3 \cdot 9H_2O$ contains many oriented water molecules and shows anomalies in the dielectric and calorimetric properties. Thermally stimulated depolarization measurements also show temperature peaks (Journ. Electrostatics 8 221 [1980]). To obtain the measurements, the crystal is raised to a relatively high temperature (310°K) and polarized with a relatively large (5×10^5V m^{-1}) electric field. After polarization the temperature of the crystal is reduced (to 77°K) so that the relaxation time is very long and the polarization is frozen in. Heating the crystal at a constant rate in zero external electric field causes reorientation of the dipoles and results in a displacement current that varies with temperature. The measurements show peaks at several temperatures independent of the value of the polarizing field. The data are interpreted to show a locking of the water dipoles at low temperatures, which is reduced as the temperature increases until thermal motion is sufficient to give rise to hydrogen bonding with the sulfate molecules and coordination about the La^{3+} ions. Polarized Raman measurements as a function of temperature made in the laboratory also support this view.

De Saja and his colleagues recently published the results (Spectrochimi Acta 36A 425 [1980]) of polarized Raman measurements on another hydrated lanthanide sulfate $Ce_2(SO_4)_3 \cdot 9H_2O$. From measurements of both the hydrated and deuterated material, the Raman active-vibration modes of the crystals were identified. The different structural roles of the two types of water molecules were also determined and a configurational scheme was proposed for them.

A new technique in which microhardness is used has been developed for the study of phase transitions. Vickers microhardness is determined by measuring the size of the permanent indentation made in a material surface by a pyramidally shaped indenter. At Valladolid a microhardness tester used in conjunction with a variable temperature cell permitted microhardness measurements to be made quickly and accurately as a function of temperature (J. Phys. E. Sci. Instrum. 14 71 [1981]). The method has been applied to Rochelle salt, a well-known ferroelectric that has two Curie temperatures. Maxima in the microhardness caused by structural changes correlate with the results of other types of measurements for both the hydrated and deuterated forms of the salt. Mrs. de Saja plans to continue the measurements on other ferroelectric and ferroelastic materials.

J. A. Alonso is a solid-state theorist who worked with L. Girafalco at the University of Pennsylvania. Alonso described his recent theoretical work. Using a cellular, self-consistent density functional method, he and his co-workers calculated the chemical binding properties (J. Phys. F: Metal Phys. 11 2045 [1981]) and the contributions to the bulk modulus (Phys. Stat. Sol. 104 307 [1981]) for the alkali metals. In the latter study, the bulk modulus was separated into two parts: that arising from a constant electron density and a compensating uniform background, and that arising from the inhomogeneity of the electron density. Both contributions were calculated as a function of volume and their sum, the theoretical bulk modulus, agreed with the results of pressure experiments.

Alonso is also studying solid solubility (Phys. Rev. B 22 5583 [1980]); he developed a three-parameter method that is claimed to give better predictions than the usual rules. Using the atomic volume and the electronegativity and electron density at the boundary of the atomic cell as parameters, the solid solubility is characterized better than it is by a two-parameter model in that fewer exceptions occur.

In a continuation of this type of analysis, parameterization of solid solubility was carried out with two orbital radii coordinates formed from the atomic psuedopotentials. Although results were encouraging, they were not as good as those obtained using the three-parameter thermochemical parameters mentioned above. Alonso plans to continue his work by

refining the orbital radii parameters and by extending the study to liquid alloys.

J.R. Neighbours

Naval Postgraduate School
Monterey, CA

SOLID STATE PHYSICS AT THE UNIVERSITY OF ZARAGOZA

The University of Zaragoza, Spain, is an old institution that dates back to 1474. The buildings used by the 27,000 students and the 1,400 faculty members however, are relatively new. The Physics Department administers to about 350 students and graduates an average of 40 to 50 each per year from the 5-year physics course.

R. Alcala, head of the solid-state group, told the author that the main interest of the group was defects in insulators. Alcala and P.J. Alonso have studied extensively the optical properties of various fluorides doped with transition metals. Their thermoluminescence measurements (J. Luminescence 21 147 [1980]) of low-temperature x-ray irradiated CaF_2 doped with Mn, Co and Ni showed that the glow peaks obtained upon warming the samples from 80°K had the same spectral distribution as x-ray-excited luminescence. X-ray irradiation produces point defects consisting of the impurity atom in several different states of ionization.

In collaboration with H.W. Den Hartog (Univ. of Groningen, The Netherlands) the group made electron paramagnetic resonance (EPR) measurements of Ni doped CaF_2, before and after room temperature irradiation with x-rays, which showed that Ni^+ concentration increased upon irradiation and that at least two kinds of Ni^+ centers were present. One was thought to be associated with a $(NiF_4)^{3-}$ molecular ion, the other with a Ni^{3+} ion substituted into a Ca^{2+} position (Phys. Rev. B21, 3826 [1980]). Optical absorption spectra (Phys. Stat. Sol. 100, 721 [1980]) and luminescence (J. Luminescence 22, 139 [1981]) were also determined in collaboration with Den Hartog. The measurements agree with the EPR results, provided several of the emission bands are attributed to Ni^{2+} centers formed by ionization of the Ni^+ centers. The optical properties of Mn centers in SrF_2 (J. Phys. C; Solid St. Phys. 13, 6049 [1980]), CaF_2 (Phys. Stat. Sol. 98, 315 [1980]) and CdF_2 (J. Luminescence 22, 321 [1981]) were also measured and the band transitions were assigned.

V.M. Orera, another member of the solid-state group, collaborated with Alcala on part of the work on transition metal doped CaF_2 (Phys. Stat. Sol. 99, 585 [1980]). Orera was a guest scientist at Oak Ridge National Laboratory during the 1978-79 academic year. During that period he collaborated with Y. Chen and M.M. Abraham of Oak Ridge on studies of the effects of Li impurities on the mechanical properties of MgO (Phil. Mag. A41, 431 [1980]; Phil. Mag. A41, 63 [1981]) and the optical properties of CaO (Phys. Rev. B21, 1258 [1980]; Phys. Rev. B23, 51 [1981]). After returning to Spain he continued the MgO studies and has published a paper on flow stress (Phys. Stat. Sol. 65, 293 [1981]).

Alcala and Orera said that the solid-state group was turning from the study of small single defects in insulators to experiments on aggregates of defects or impurities. With R. Cases, they have measured the optical absorption bands in CsBr and CsI resulting from colloidal Cs (Solid State Comm. 33, 151 [1980]). Comparison of the experimental results with Mie scattering theory was used to obtain the colloidal radii, which were then used to make a mean free path correction to the dielectric constant of the particles. The variation of the dielectric constant with temperature was thought to explain the shift of the absorption bands with temperature.

In addition to his previously mentioned work at Oak Ridge, Orera also collaborated with F.A. Modine to measure the magneto-optical properties of metallic colloids in insulators: Na in NaCl and Ca in CaF_2 (Phys. Rev. B. 24, 1159 [1981]). Although they did not find a particle size distribution function for Na that would allow a fit of the data, they did find that the magnetic circular dichroism was the derivative of the observed optical density spectra.

For Ca, a particle size distribution function previously determined by Alcala and Orera allows data sets from both optical density and magnetic circular dichroism to be fitted quite well. Because metallic colloids are stable end products of radiation damage and have also been produced by ion implantation, Alcala and Orera intend to continue this work. They will probably concentrate on the effects of substitutional third atom impurities in ionic crystals.

J.R. Neighbours

Naval Postgraduate School
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NEWS & NOTES

ULTRASONIC CONTROL DEVICE

A new ultrasonic system for controlling appliances and machines is being manufactured in Britain. The transmitter is about the size of a hand calculator; it can control up to 10 channels. The signals are reportedly quite reliably bounced off the walls of a house, and there is no line-of-sight requirement. Hospital trials for handicapped people have been promising; the Norfolk Health Authority expects to use the system in hospitals and in patients' homes.

One remarkable feature of the system: it was designed by a 15-year-old boy, Nadeem Saddiqui, while at Wymondham College in Norfolk. The manufacturer, P.C.D. Ltd. of Farnborough, Hants, England has agreed to pay Saddiqui 8 pounds (about $14.40) for each model sold over the next five years.

Nicholas A. Bond, Jr.

ONR London

INDEXES FOR LIVING STANDARDS AND DISCOMFORT

The Organization for Economic Cooperation and Development (OECD), based in Paris, has many ways for tracking the economic progress of nations. Recent publications of indexes for "standard of living" and "public discomfort" not only permit some interesting comparisons, but give an insight into the way that big international economic agencies face the problem of combining several indicators into a single number.

The OECD "discomfort" measure is taken as the simple sum of a percentage of unemployment and the percentage of rise in consumer prices. Such a number might indicate the extent to which any nation is solving economic problems. Recently, for example, average inflation over the seven major member countries has dropped to about 9.5%, but the unemployment rate is rising and by summer it may be higher than the inflation rate. Britain's crossover occurred in February of this year; during that month, inflation in the UK had dropped to 11% while the proportion of unemployed was 11.8%. In 1974, the OECD mean discomfort index was 17.1, because an inflation rate of 13.4% was added to an unemployment rate of 3.7%; the combined number is about the same now, but with unemployment as the main culprit.

For overall comparison of living standards between countries or areas, a conventional method is to calculate the gross national product per capita, say in dollars or pounds or francs. But the method has serious drawbacks: it focuses only on recorded productivity items, and it is also subject to extreme exchange rate fluctuations. To overcome some of these difficulties, OECD has recently introduced a "Purchasing Power" concept; a standard collection of goods and services is priced in the various countries, and the real living standard is determined by how much of this standard basket the average consumer can afford. The table below shows the Purchasing Power (PP) ranking of several countries; inside the parentheses are the rankings on a simple gross domestic product basis, corrected for exchange rates. As one might expect, the US is first on a Purchasing Power determination; but because of the dollar's exchange-rate fluctuations against the West German deutsche mark and other currencies, a rawscore exchange-rate comparison puts West Germany on top. Britain, which once had the highest living standard in the world, now stands below other Northern European countries.

	PP Rank Country	GDP Converted Rank
1	USA	(7)
2	Luxembourg	(3)
3	Germany	(1)
4	Denmark	(2)
5	France	(4)
6	Belgium	(6)
7	Netherlands	(5)
8	Japan	(10)
9	Austria	(8)
10	UK	(9)
11	Italy	(11)
12	Spain	(12)
13	Ireland	(13)
14	Greece	(14)
15	Portugal	(15)

These indexes, and many others like them, are certainly useful to planners and governments. The indexes, however, do not seem to incorporate much of what is known about the psychometric and statistical aspects of combining correlated scores. It is an interesting question why much of the OECD work, which is organized around an elaborate data base of some 1,300 prices, finally relies on simple summation measures to express some very complex phenomena.

Nicholas A. Bond, Jr.

ONR London

FELLOWSHIP IN THE ROYAL SOCIETY, UK

Fellowship in the Royal Society is considered by many to be one of the most prestigious scientific honors in the world. As of last year, there were 896 fellows (including 30 females); about 40 new fellows are selected each year. Herbert Eisener recently reported in the New Scientist that 258 of these honored people,

or some 36% of the total, were graduates of Cambridge University; 22% came from London University, and 12% were from Oxford. Nearly every year, these three schools account for a great majority of elected fellows.

The data indicate that the three schools (the "Oxbridge-London" circuit) are definitely the source of scientific leadership in Britain. Extensive British studies have demonstrated that this is probably because the best students enter those universities. (That finding agrees with American studies on the productivity of universities; the doctoral graduates of great institutions like Harvard and Yale tend to produce more cited research in their careers. But, when the quality of student input is partialled out, the Harvards and Yales apparently are no more productive of research scholars than the ordinary state university; they simply get better people to start with.) There are some puzzles remaining, though, such as how Cambridge achieved such predominance over Oxford. Both these prestigious universities date from medieval times, both have the finest professors and facilities, and both impose nearly identical admission requirements. A cynical observation might be that, once started, a Cambridge selection cycle is simply perpetuated as a British old-boy network. That particular hypothesis is unlikely, given the rigorous FRS selection boards and the high general reputation and excellence of fellows.

Nicholas A. Bond, Jr.

ONR London

NEW ABORTION DRUG

Prof. Etinenne-Emile Baulieu, of the French Institute of Medical Research, has reported the discovery of a new antiprogesterone steroid that apparently causes abortion and also has contraceptive effects. When a capsule dose of 200 mg per day was given to 11 Swiss women who were between 6 and 8 weeks pregnant, 9 had immediate abortions. Also, when the substance was administered to nonpregnant women, normal menstruation occurred within 48 hours, with the following menstrual cycle being completely normal. Reportedly, no serious after effects or side effects have been observed.

The formula for the drug is secret. The product is now undergoing further trials in humans and animals. According to some reports, the drug could be on the market within 3 years. It could have a revolutionary effect on practices associated with contraception and abortion.

Nicholas A. Bond, Jr.

ONR London

THE MALE-FEMALE SPORT GAP

In the last 10 years, the difference between the men's and women's marathon records has decreased from 30% to less than 12%. The decreasing gap seems rather general; for the five major track events from 100 meters to 1,500 meters, it is now under 10%. In Olympic swimming, some of the male world record holders of a few years ago, such as Mark Spitz, saw their winning times surpassed by women in 1981.

It seems that it is the longer endurance events in which the best women athletes most nearly approximate the best men performances. Elizabeth Ferris, a former British Olympic diving medalist and now a UK specialist in sports medicine, believes that this may be partly because women seem to have a more efficient heat regulating system and a more effective utilization of body fat as fuel. She believes that the marathon gap will decrease steadily; in one recent provincial marathon, women reportedly finished among the top 20 contestants.

There is one athletic field in which women are certainly champions, and that is long-distance sea swimming. For the long swim across the English Channel, women have held both the one-way and the two-way nonstop records for some years now; interestingly enough, some men swimmers have claimed that women have an unfair advantage in cold-water swimming, because of subcutaneous fat and other physiological factors. However that may be, the athletic achievements by East German women show what can be done by excellent facilities, coaching, public support, and continuous competition. In that country, the gaps between men's and women's performances are lower than almost anywhere else.

Nicholas A. Bond, Jr.

ONR London

BADGERS, NATURALISTS, AND TB

There were several outbursts of cattle tuberculosis in Britain in the 1960s and 1970s. Eventually, the badger came to be suspected as the disease source, and in certain areas badgers were trapped or gassed. Publicity about the destructions led to protests from some naturalists; TV programs and letters to the editor opposed the animal-control effort.

A research team led by Anthony Little at the UK Central Veterinary Laboratory recently reported on a study that gave conclusive evidence of the badger as a principal transmitter of the tuberculosis bacterium. All animals in four small areas were trapped; besides the badgers, many other animals such as rats, weasels, rabbits, and foxes were captured and tested. The bacterium was found in only two

rats and one fox, but it was found in many badgers, and the badgers were the only animals with infected tuberculosis lesions.

The badger sites within a particular area were gassed in 1975 and 1976; by 1978 and 1979, there was no tuberculosis in the area. In 1979, 59 of the gassed badger sites were reopened. Since then, more than 20 of the old sites have been reoccupied by badgers that came from nearby farms. The experiment shows once more that a careful eradication program can eventually benefit all parties, but that to be publicly acceptable it must be accompanied by careful analytical proof of disease transmittal.

Nicholas A. Bond, Jr.

ONR London

ONR CONSPONSORED CONFERENCES

ONR London can nonimate two registration-free participants in the conferences it supports. Readers who are interested in such participation should contact the Chief Scientist, ONR London, as soon as possible.

Symposium on Coastal Problems in the Mediterranean, Venice, Italy, 10-14 May 1982.

International Meeting on Analysis of Sample Survey Data & Sequential Analysis, Jerusalem, Israel, 14-18 June 1982.

NATO ASI on Numerical Taxonomy, Bad Windsheim, FRG, 4-16 July 1982.

1st Biennial National Atomic Spectroscopy Symposium, Sheffield, UK, 13-15 July 1982.

International Conference on Practical Bayesian Statistics, Cambridge, UK, 21-24 July 1982.

IXth IUPAC Symposium on Photochemistry, Univ. of Pau, France, 25-31 July 1982.

XI International Symposium on Mathematical Programming, Bonn, FRG, 23-27 August 1982.

4th Europhysical Topical Conference on Lattice Defects in Ionic Crystals, Dublin, Ireland, 30 August - 3 September 1982.

14th Europhysics Conference on Macromolecular Physics, "Polymer Crystals: Structure & Morphology," Vilafranca del Penedes, Spain, 21-24 September 1982.

EUROPEAN VISITORS TO THE US SUPPORTED BY ONR LONDON

Visitor	Affiliation	Navy Lab./Org. to be Visited
Dr. L. Bengtsson	ECMWF, Reading, Berks	NEPRF, Monterey (June or July 1982)
Dr. J. Cousins	Propellants, Explosives, and Rocket Motor Establishment, Westcott, Aylesbury, UK	NWC, China Lake, (1 July 1982) US Navy Consultant, Inst. of Technology, Pasadena, CA, (28 June 1982)
Dr. C. Leijnse	Industrial Acrodynamics, Aerospace Lab., Amsterdam, The Netherlands	NAVAIR (11 May 1982) NTEC, Orlando, FL (13 May 1982)
Dr. John Nelder	Rothamsted Experimental Station, Harpenden, Herts, UK	ONR (4 May 1982)
Dr. W.J. Stronge	Univ. Engn. Dept., Cambridge, UK	NRL NWC, China Lake NPS, Monterey (Late June or early July)

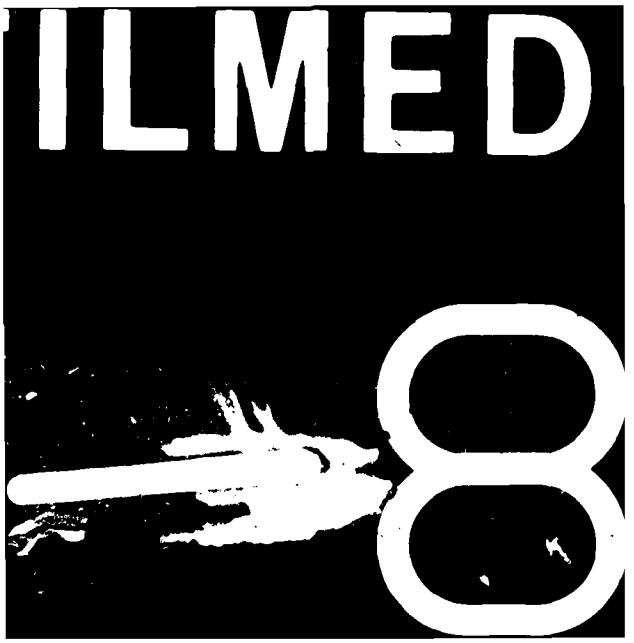
ESN 36-5 (1982)

European Scientific Notes is a Class I Periodical prepared and distributed by the Office of Naval Research London in accordance with NAVEXOS-P-35. Prepared and submitted by the scientific and technical staff.

F.A. Richards
Chief Scientist

L.B. Sykes
Captain, USN
Commanding Officer

Dr. D.R. Barr	Operations Research
Dr. N.A. Bond, Jr.	Psychology
LCDR R.W. Booker	Environmental Systems and Military Oceanography
Dr. P.A. Clarkin	Material Sciences
Dr. R.L. Derr	Liaison Technologist
LCDR M.D. Schroeder	Undersea Systems
CDR J.A. Strada	Aerospace Systems
CDR M.G. Surdyk	Command, Control and Communications
Mr. Y.S. Wu	Information Systems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